CHOLERA

PETTENKOFER

HIME

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H. Franklin Parsons

CHOLERA.

CORRIGENDA.

Page 65, line 12, for "one-third" read "two-thirds."
„ „ „ „ „ "2 drachms" read "4 drachms."
„ 45, last line of note, for "magore" read "majore."

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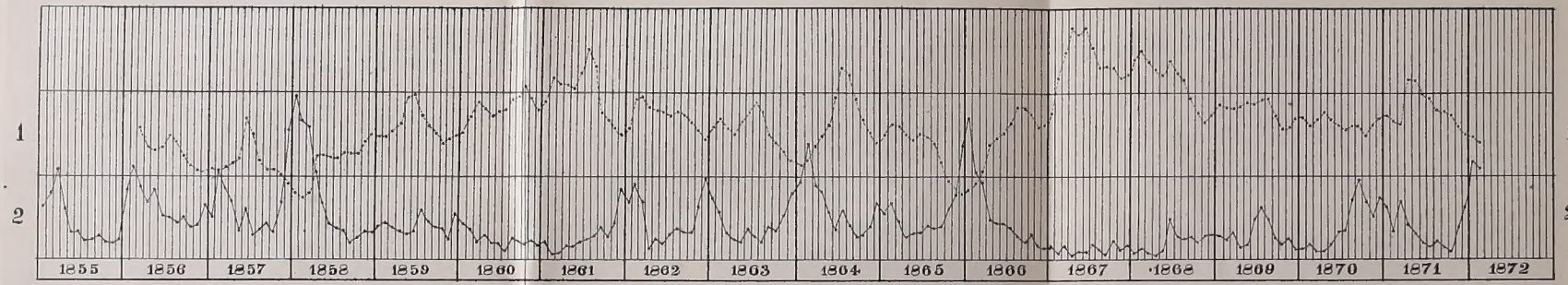
A CHART

SHOWING THE VARIATION IN THE

GROUND WATER AND IN THE MORTALITY FROM TYPHOID FEVER IN MUNICH.



1.—VARIATION IN THE GROUND WATER.
2.—MORTALITY FROM TYPHOID FEVER

CHOLERA:

HOW TO PREVENT AND RESIST IT.

BY

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From the German.

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REVISED BY DR. von PETTENKOFER.

WITH ILLUSTRATIONS AND A CHART.

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I desire to express my hearty thanks to Prof. von Pettenkofer for his kindness in correcting the proof-sheets of the following pages, also for some valuable suggestions made. The translation has thus had the benefit of the author's own revision. With the contents of the Introduction he has also expressed his entire agreement. I am indebted to Dr. Hess for the use of his *clichés* for the illustrations in the Introduction. A good deal of information on subjects touched on in the following pages will be found in Prof. von Pettenkofer's Lectures, "Ueber die Beziehungen der Luft zu Kleidung, Wohnung und Boden," which have been ably translated by Dr. Hess.

T. W. H.

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INTRODUCTION.

"Morbis enim quoque quasdam leges natura posuit."

PLINIUS.

THE investigations of Prof. von Pettenkofer as to the nature and mode of propagation of Asiatic Cholera and Typhoid Fever (which diseases, as well as Yellow Fever, seem to possess many generic characteristics in common,) are unequalled in the history of medicine, both as regards their value, and the philosophical and unwearied manner in which they have been conducted. The importance which has been attached to his opinions on the subject abroad suggested to me the desirability of bringing before the English public his latest work on the subject.* His views are but little known in this country; even our medical text-books are silent on the subject; and I am not aware that any results of measurements of the Ground-water have ever been published in this country. Hence no general authoritative opinion as to the merits of those observations has been possible, either on the part of medical or other authorities.

Cholera is a subject which concerns most immediately, not

* Its production has been delayed until the Report of the Conference Sanitaire International, recently held in Vienna, on the subject of Cholera had been issued. The recognition of the importance of so many of Prof. von Pettenkofer's opinions by most of the delegates at this great international scientific gathering offers a striking contrast to the reception generally given to them but a few years ago.

I may state that, in translating, I have endeavoured to reproduce the meaning rather than the words of the author, acting up to the advice,

"Nec verbum verbo curabis reddere fidus
Interpres."

I trust, however, that I have not afforded any grounds for the application of the proverb "Traduttore traditore." Notes introduced by me are signed "T. W. H."

only our personal and national interests, but, it may be said without exaggeration, it concerns the whole human race. It provides itself a home in every clime, alike on the burning plains of India, in the icy North, and in the temperate regions of Europe. Each time that it has visited Europe, it has shown a greater reluctance to depart. How long its present visitation, which England has hitherto escaped, and which may be said to date from 1865, will last, no man knows. It has even been asserted, with some plausibility, that it shows a strong tendency to abandon its birthplace in the low river-lands of North-East India, and to establish itself as a resident in countries nearer to Europe.

That the study of the natural history of this dread disease (the surest introduction to its successful treatment) would be greatly advanced, and our means of defence against its ravages increased, by the non-medical world taking an active interest in it, I am fully persuaded. Investigations as to its mode of propagation, its dependence on influences connected with the soil and the atmosphere, its portability, contagiousness, etc., require no previous medical training; and any disadvantages which might result from want of medical knowledge would be more than counterbalanced by the fact that the conclusions would be arrived at more free from prejudice than is often the case with medical men, who can scarcely avoid entering upon such observations with their mind somewhat biassed by their early training. For this reason I thought it more advantageous to bring out a translation of a popular exposition of the leading points of Prof. von Pettenkofer's views on Cholera, rather than of one of his numerous works* on the subject which are more

* Among these may be mentioned—

Ueber die Verbreitungsart der Cholera, Zeitschrift für Biologie, Band I., Heft 3 and 4, Munich, 1865.

Die sächsischen Cholera-Epidemien des Jahres 1865 : Zeitschr. für Biologie, Band II., Heft 1, Munich, 1866.

Die Immunität von Lyon gegen Cholera, und das Vorkommen der Cholera auf Seeschiffen, Zeitschr. für Biologie, Band IV., Heft 4, Munich, 1868.

Boden und Grundwasser in ihren Beziehungen zu Cholera und Typhus. Seperat-Abdruck aus der Zeitschr. f. Biologie, Munich, 1869.

Fünf Fragen ueber Cholera, Munich.

especially intended for medical readers. In contending with Cholera we are fighting an unknown and invisible enemy, and only knowledge can give us power in the struggle. The more spies are engaged in tracking our enemy, the more likely will be his discovery. I feel sanguine, however, that the little work will be found worthy of perusal even by medical readers.

Whether the *rôle* played by the soil and the water it contains be regarded as *essential* or not to the development of Cholera, none can deny the necessity of endeavouring to maintain the ground on which we dwell in the greatest possible state of cleanliness, not only as regards the surface, but also down to a considerable depth. The importance of the latter will appear more evident in the sequel.

It has long appeared to me that legislative interference is urgently needed to prevent the constant and increasing pollution of the ground on which our houses are built. When we come to consider the effects produced by the unroofed, undrained, and unpaved ashpits, so common in our towns and villages, we must be astounded at the apathy which has permitted such a monster evil to exist and increase under our very eyes. The excrements of several people, and a large amount of putrescible matter, are daily discharged into these pits, and left there to rot, freely exposed to the air and rains, until the pit becomes full, a period which may extend to months, or even years.* The area of sewage and other foul matter thus exposed to poison the atmosphere is enormous. In a large place such as Sheffield there are at least some fifteen acres of ashpits out of the total area of the town. The rainwater and liquid offal sink to the bottom, and form a solution containing a large part of the rotting contents of the pit, and as such sink into the ground. This foul stuff does not sink down straight into some distant stygian region;

Verbreitungsart der Cholera in Indien, nebst einem Atlas, Braunschweig, Vieweg u. Sohn, 1871.

Ueber den gegenwartigen Stand der Cholera-Frage, Munich, Oldenbourg, 1873.

* If proof of this statement be desired, it will be found but too abundantly in various Reports of the Medical Officer of the Privy Council.

it saturates the ground for a considerable distance in every direction. The smaller the extent of ground it pollutes thus, the worse must it be for the dwellers above; because if the nuisance remain confined to a small area, the pollution of that part will necessarily be greater than if it were diluted, so to say, by being spread over a considerable space; the poison will be more concentrated, and the beneficial action which the soil has (when clean) on sewage must be exhausted.

This evil might be diminished by compelling every landlord to put a roof over the ashpits of his houses, so as to prevent the entrance of the rain, and also to make the ashpits water-tight, and to drain them so that their fluid contents should all pass into the nearest sewer. The system of open ashpits (or open cesspools, for as at present commonly arranged they may be regarded as synonymous,) can never be but a nuisance, and source of public danger.

Nothing can be more erroneous than the common idea that the atmosphere ends where the ground begins. The ground (using the term in its general acceptation) is not half so solid as it seems, and currents of gas and water circulate freely through almost any part of it except the most compact clay and rock. It is common enough to see water flowing, sometimes in considerable quantities, from the side of a bank or cliff; and this water may have come a long distance to the point of escape. The whole art of drainage, so useful in agricultural and sanitary aspects, depends on the fact that water will run through the apparently solid ground: and the engineer conducts it into a conduit which he has placed in the most advantageous position for carrying it off. If a fluid like water can make its way through the ground, it will not be surprising that air, which is 770 times lighter and more moveable than water, should very readily traverse it. Gravel soil, though apparently so solid, and able to support large houses, is in reality often little more than semi-solid. A very compact gravel will consist of pores or air-holes to the extent of one-third of its bulk. A house built on such a formation does not therefore stand on what can be called a solid, air-tight foundation, but on a mixture of two parts of small stones and one part of

air; and the interspaces between the stones may become filled with water, or any kind of gas, as well as air.

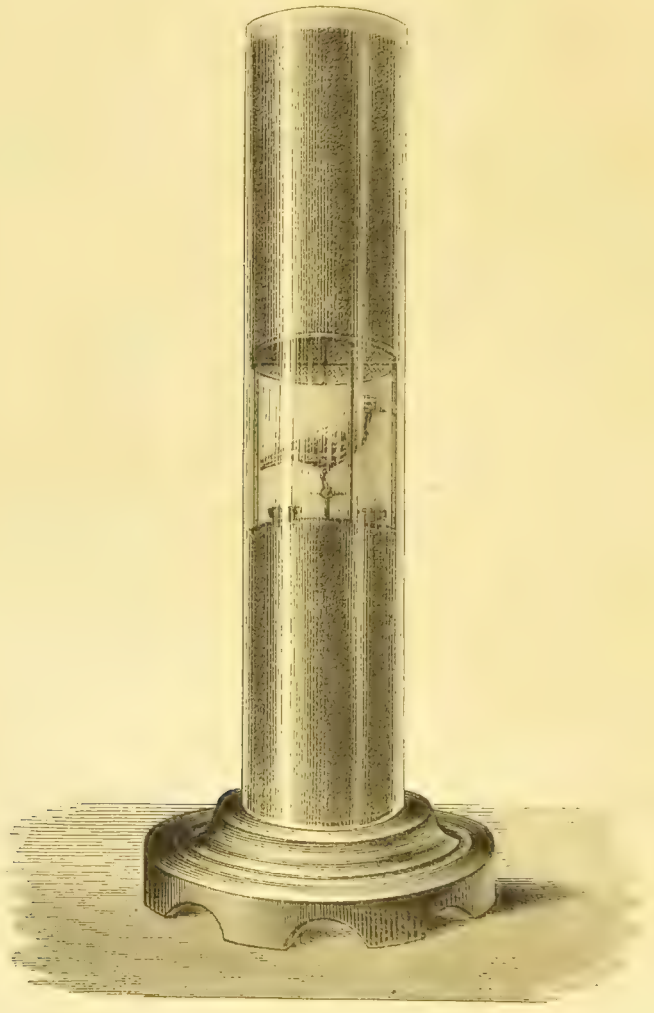
Even far more compact substances than gravel contain within them pores whose combined volume forms a considerable part of the whole mass. For instance, I have found that new, well-baked bricks will absorb as much as half a pint of water; a compact sandstone, suitable for building purposes, will in a short time absorb from five to six per cent. of its own weight of water.* The water of course can only penetrate into the open spaces which exist in the solid material. The large quantity of water which can be absorbed will give some idea of the extent of the pores, and of the sort of honeycomb material of which the walls of our houses are built.

The following experiments, devised by Prof. von Pettenkofer, illustrate the above remarks in a striking manner. The first illustration represents a cylinder of solid dry mortar, 5 inches by 1½. It is covered with wax, except at the ends, and to each of these ends is attached, by means of wax, a funnel which terminates in a tube. By blowing through one tube, even though no great effort be made, it will be found that the breath will pass through the solid mortar with sufficient force to blow aside the flame of a candle held near the opposite tube. A

block of apparently solid gravel contains one-third as much air as stone, and a house built on such a foundation is therefore practically resting on a stone support which stands in air.

* This is true of a fine hard sandstone extensively used for building in Sheffield. A block of it measuring 5 in. by 5 in. by 2½ in. high, weighing when dry 6 lb., will absorb 4 to 4½ oz. of water in a few hours.

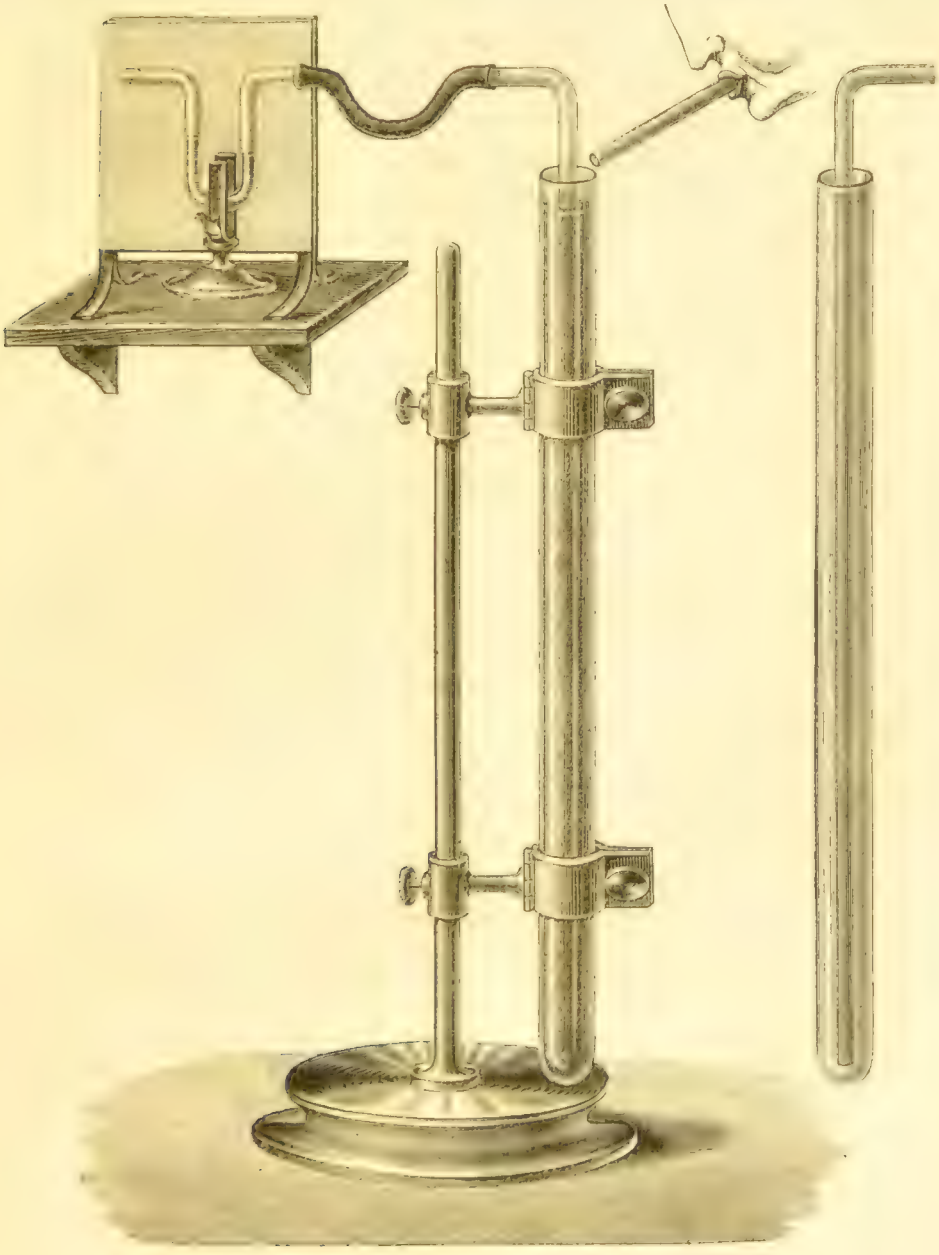
The next illustration is intended to show how readily air will pass through gravel soil. It represents a canary bird placed in a little chamber so arranged that no air can reach it unless it pass through the gravel which fills the upper and lower part of the glass cylinder. The bird receives abundance



of air for respiration, all of which it must draw through the gravel.

Ocular demonstration of the same fact can be most strikingly afforded by the experiment illustrated in the next figure. It represents a tall glass tube filled with gravel, of a much greater

depth than that shown in the last figure. A smaller glass tube is placed inside of it, one open end of it reaching to the



bottom. The other open end of this smaller tube is attached, by means of a piece of india-rubber tube, to the piece of glass tube, bent to the form of the letter U, (on the left side,

upper part,) the curved part of which contains some water.* If a person blow, as represented in the figure, on the surface of the gravel, the water in the U-shaped tube will be seen to alter its position, the level of the side next the person who is blowing becoming lowered, and the other proportionately elevated. The depression of the fluid is caused by the force of the air blown through the gravel; because it ascends from the bottom of the gravel through the small glass tube, passes through the india-rubber tube, and thus reaches the water.

What can be done thus by the simple blowing by the mouth must be effected on a far greater scale by the force of the wind, which at times exerts a pressure of many pounds on every square foot of the ground which it touches.† Other forces, such as diffusion and difference of temperature between the surface and the underground regions, will necessarily produce a similar effect on the gases, which, as has been shown, move with such readiness through porous soils. When the air in our chimneys is warmed by the fire below, it expands and ascends, being forced upwards by the colder and heavier air below. Thus a current of air is established, flowing up the chimney, and drawing with it the smoke and noxious gases produced by the combustion of the coal. Just as the hot air rising through the chimney causes a current of air from the room, so the warmer air within our houses causes a current to flow from the cellars, and from the ground beneath them, when the difference of temperature is sufficient, which it very frequently is in our houses, where fires are almost permanently maintained in the kitchens and other parts. Unless the ground from which it emanates is pure, it cannot be expected that the air which is thus drawn from it will be so; and thus the genial warmth of our houses may become the cause of the intro-

* A tube thus arranged is termed a manometer.

† A 'brisk wind,' blowing at the rate of 22 feet per second, exerts a pressure of 1·107 pounds on each square foot; a 'high wind,' blowing at the rate of 66 feet per second, exerts a pressure of nearly 10 pounds; a 'hurricane' will act on the ground with a force of 50 pounds, and more, on each square foot.

duction of foul and pestiferous air from the polluted ground below.

The following circumstance, related by Prof. von Pettenkofer,* is a remarkable illustration of the suction power thus exerted by the warm and ascending air inside our houses. In December 1859, the chaplain of St. Ulrich's church, at Augsburg, was suddenly seized with a serious illness, the nature and cause of which were inexplicable. The Sisters of Mercy who nursed him were, one after another, seized with the same symptoms, pain and congestion of the head, fainting, etc. The symptoms always became aggravated when the weather got colder. After some time, no improvement having appeared, a friend who came to visit him one day exclaimed, on entering the room, "There is an escape of gas." This was denied by all connected with the house, and declared by the doctor to be immaterial, as the patient was now pronounced to be undoubtedly suffering from fever. At length, however, a person was sent for to the gas-office, and he at once said there was an escape, but confessed himself unable to discover its source. The patient, however, acted on the hint, and having left the house, in spite of the doctor, recovered in a few days. No sooner was he gone, and the windows of his apartments thrown open, and the fire let out, than his next neighbour got attacked by the very same symptoms. He, too, recovered at once by a rapid flight from the house.

It was impossible to examine the underground pipes at the time, as the ground was frozen hard. However, at the end of six days this was done, and an escape was discovered in the main pipe, which ran in the centre of the street, some twenty feet distant, the gas escaping in such quantities as to burn briskly when lighted.

The coldness of the weather had necessitated larger fires in the house, and the increased heat developed a current of air from the ground into the house, the gas being sucked up with it. When the first patient had left the house, his room was allowed to cool, and the current of air and gas was thus diverted to the apartments of his neighbour.

* Beziehungen der Luft zu Kleidung, Wohnung, etc. Anhang., p. 111. Braunschweig, Viewe 1872.

The direction in which the current of air will flow through the ground is dependent on the same physical laws which produce the upward draught in a warm chimney. When the air in the house is warmer than that outside, the cold air outside will force the air in the ground to ascend into the warmer house, and it will of course convey with it such portable substances as it meets with, whether they be wholesome or whether they be noxious. As the outside air is usually colder than that within our houses during the Autumn, Winter, and Spring, the direction which the Ground-air will take during these seasons must be upwards into the warm houses. But in Summer our houses are cooler than the outside air, and consequently the temperature of the air entering them is lowered, and it flows in the direction from the roof to the cellar, and it will therefore displace the air in the ground, forcing it to ascend towards the warmer surface of the ground and the warmer air outside. Thus the currents will be in opposite directions according as the air outside our houses is warmer or colder than that inside them.

These brief remarks may serve to indicate that inquiry into this subject, which hitherto has remained almost untouched, may be expected to yield most valuable results.

That minute particles of matter, probably of organic nature, are the active agents in propagating many forms of disease, has been rendered more and more probable by recent researches. The manner in which they enter our bodies is uncertain, but it is more likely that it is through the lungs, than by the stomach or skin. Hence the vast importance of excluding air coming from an impure source. It is impossible to prevent the circulation of the Ground-air in the manner described, but the direction of its flow may be altered so as to obviate, in a great degree, the dangers resulting from it. The following ingenious suggestion* as to this point is well worthy of attention, especially on the part of architects and builders. In order to encourage the flow of the Ground-air, and to direct

* Boden-Ventilation, als Schutzmittel wider Cholera und Typhus, vorgeschlagen von C. L. Staebe, mit Zusatzen herausgegeben von Dr. Paul Niemeyer. Magdeburg, G. A. Gloeckner. 1873.

it into a harmless channel, the chimneys from the lower storey should be continued downward into the cellar, and terminate by an open orifice in a chamber which is to be formed beneath the cellar floor. This chamber is to be 1 foot deep, and of the size of the cellar; and its top is to be carefully asphalted, so as to render it as airtight as possible, the object being to prevent the Ground-air escaping from the chamber beneath the floor except by the chimney. This chimney will carry off the Ground-air which rises into it from below during Autumn, Winter, and Spring, and thus all foul gases and disease germs emanating from the soil will be conveyed out of the house, without coming in contact with the inhabitants. During the season when the Ground-air sinks within the houses (Summer), an abundant supply of fresh air will be conveyed into the underground chamber, and being cooled will pass through the ground and rise to the warmer surface outside the house. In this way a thorough and constant ventilation of the ground would be maintained. The very best results might be expected from the adoption of such a plan in building, and its adaptation to houses already built would not be very costly.

It is often very difficult to get people to realize the necessity or advisability for a measure the results of which do not immediately strike some of their senses. The frightful loss of life which occurs annually in England from diseases originating in preventable nuisances, is one of the saddest instances of the truth of this remark.

Nearly a million of people were killed in England during the ten years 1850—59 by diseases which without a doubt are to a great extent preventable, the principal cause of such a loss of life being the reckless pollution of the ground by sewage. And yet, while this deadly nuisance is tolerated, we have Smoke Inspectors appointed by law to observe the length of time *black* smoke issues from factory chimneys, and summon the manufacturer who allows it to rise for more than a certain number of minutes.*

* It is certainly astonishing that the enormous volumes of smoke and gas discharged into the air in manufacturing towns do not render it unfit for breathing. In Manchester, many millions of tons of coal are

No one can speak more strongly or authoritatively on this subject than the respected Medical Officer of the Privy Council. He says,* "It seems certain that the deaths which occur in this country are fully a third more than they would be if an existing knowledge of the chief causes of diseases were reasonably well applied throughout the country; that of deaths which, in this sense, may be called preventable, the average yearly number in England and Wales is now about 120,000; and that of the 120,000 cases of preventable suffering which thus, in every year, attain their final place in the death register, each unit represents a larger or smaller group of other cases in which preventable disease not ending in death, though often of far-reaching ill effects on life, has been suffered."

The pollution by sewage produces a condition of the soil which is most favourable for the development of the germs of Cholera, Typhoid Fever, and other scourges of humanity. There is no evidence that sewage of itself can produce either Cholera or Typhoid Fever. If it could, we should never be free from either disease. The speedy and effectual removal or destruction of sewage is called for when Cholera is not present as much as when it is impending or already raging. But there is no doubt that persons who live on a soil impregnated with sewage suffer permanently from a higher rate of mortality than those who dwell on a healthy soil. In this we may find the chief cause of the much higher death-rate which prevails in cities in comparison with country districts—a contrast so striking that the epithet

"Edax hominum urbs"

is fully justified.

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burned yearly, and yet Prof. Roscoe has proved that the air in that town does not contain an appreciably greater quantity of carbonic acid than the air in the country. (*Vide* Proceedings of the Manchester Literary and Philosophical Society, 1863-4.) This result must be due to the great rapidity with which the products of combustion become diffused through the open air. Within our houses, however, this process takes place much more slowly than in the open air, and hence the rapidity with which rooms can become overcharged with carbonic acid.

* See his Thirteenth Report.

The advantages (hygienic) of a rural life cannot, as they so often are, be correctly attributed to the less exciting habits, simpler fare, earlier hours, etc., as contrasted with the

> "ten thousand baneful arts combined,
> To pamper luxury and thin mankind,"

which are supposed to prevail in towns. There can be little doubt that the greater healthfulness of the rustic is chiefly due to the greater purity of the soil, and the consequently greater purity of the atmosphere he chiefly lives in, for it must be remembered that the greater part of the population pass more of their time within doors than in the open air. The ground around a country house is often impregnated, that around the town house is almost always so; but the quantity of offal discharged from the country house is infinitesimally small in proportion to the area of unimpregnated soil around; and besides the flowers, trees, and meadows, and other forms of vegetation, lend their aid in rectifying the results of man's carelessness. They do not merely charm the senses and provide us with food, but they also exercise a most beneficial influence in cleansing and ventilating the soil, and thus causing purer streams of water and air to flow from it.*

The accompanying diagram represents the variations of the Ground-water in Munich, as observed by Prof. von Pettenkofer, during a period of eighteen years, and also the variations in the mortality from Typhoid Fever there. The constant

* The increased mortality in towns must also be partly caused by the greater facility with which infectious diseases, such as smallpox, etc., can spread among a crowded town-population, in comparison with its progress in a rural district. This could be, to a great extent, obviated by the establishment of hospitals in every town for such diseases. There is no doubt that a large proportion of the cases now admitted into the surgical wards of infirmaries and hospitals could be treated quite as successfully at the patients' homes; and, besides this, a cut, bruise, sprain, fracture, or other surgical case, does not involve the relatives or neighbours of the patient in any danger. But every case of smallpox or scarlatina in a town is a source of serious danger to all around, especially among the poorer classes, who as a rule are nursed (and often with the greatest devotion) by their neighbours. I could relate many instances of poor women who have in this way brought disease and death into their own families.

manner in which the increased mortality denoted by the lower line (marked 2) accompanies a low state of the Ground-water, represented by the upper line (marked 1), must strike every one. And not only so, but the rise of the Ground-water always brings with it a diminution of the mortality. No year had so few deaths from Typhoid Fever, since 1856, as 1867; and if the chart for that year be examined, it will be found that in the same year the Ground-water rose most unusually high. The second lowest mortality occurred in 1860-61, and in that year we find the Ground-water was again very high.

A similar relation exists between the variations in the mortality from epidemics of Asiatic Cholera and the Ground-water. That such a relationship should unfailingly be found during so long a period of time is a proof that it must be more than a mere casual coincidence. A mathematical calculation made by Prof. Seidel at the end of eight years showed a probability of 36,000 to 1 that the connection was a causal one.

The same unfailing connection will be found to continue up to 1873, and the probability of a causal and not mere casual connection has therefore vastly increased. It has, in fact, reached a degree which is far greater than that which in the affairs of daily life we are accustomed to regard as dead certainty.

Those who are unaccustomed to estimate probabilities numerically will more easily understand the degree of probability implied by the figures given above, from the following illustrations. If only one prize were offered in a lottery in which there were 36,000 blanks, no one would think of risking a large sum in the hope of success, so certain would failure seem.

So uniform is the regularity with which the Post Office forwards our letters safely as addressed, that we hardly think there is the slightest risk of miscarriage, and should such a mishap occur we feel surprised. If two letters posted to a person at the same address were to miscarry successively, it would be regarded as more than suggestive of foul play, and as certainly not accidental; and if half a dozen letters, one after another, failed to arrive, we should not have the slightest doubt it was the work of some thief. The authorities would

ERRATUM.

Page 19, line 13 from bottom, for "peat" read "earth."

be so satisfied of foul play, that the thief would most probably be caught long before the sixth or seventh letter had been intercepted. If, however, a dozen letters were thus to miscarry, there would be perfect certainty in the minds of every one. And yet the probability as to the causal influence of the variations of the Ground-water is greater than if two dozen letters were to miscarry thus one after another.

As there has been a good deal of misunderstanding and misrepresentation as to the meaning of the term Ground-water as employed by Prof. von Pettenkofer, and the *rôle* which he attributes to it, it is desirable to make the matter clear.

Every kind of soil is found to be more or less damp as we dig downwards and in many we arrive at a stratum which is evidently saturated, because when the clay is removed water flows into the unoccupied place from the ground around. The stratum which is thus saturated contains no air within the pores, which exist so abundantly in most soils. The water which excludes the air from this stratum is the Ground-water. The soil above it is, as we have seen, permeable to air and water, and is said to be damp, as distinguished from the saturated stratum. This stratum must of course lie on one which is impervious to water, otherwise the Ground-water would sink into the earth. A marsh is a district the Ground-water of which rises to the surface, and the impervious stratum on which it rests is so formed that it prevents the water draining away. In fact, a marsh may be compared to a gigantic basin sunk in the earth, and filled with peat saturated with water. The basin corresponds to the water-tight stratum. The level of the Ground-water, instead of rising to the surface as in a marsh, may of course stand at any height above the impervious stratum, but the nearer the surface it is the damper must the superincumbent soil be. *In fact, the rise and fall of the Ground-water may be taken as a measure of the dampness of the ground above it, and it is for this purpose, and no other, that Prof. von Pettenkofer has observed its variations.* When we examine the accompanying chart, and find that the level of the Ground-water was high in 1864 and very low in 1865, the important lesson to be learnt is that the ground was much damper, and less of it was pervious to the air, in 1864 than in

1865. The variations of the Ground-water, therefore, are to be regarded as implying variations of the moisture of the soil.

At first sight it may seem that the state of the Ground-water could be readily measured by the amount of rainfall. This, however, is not so. Great differences are found in the level of the Ground-water in different years which had the same rainfall; and different soils are most variously affected by the same amount of rain.

The effect which a given quantity of rain will have on the soil will depend, for instance, on whether the ground was previously very dry, or saturated. In the former case, the Ground-water may continue to sink even after weeks of rain, as occurred in Munich in 1866. If the soil be very damp, and the evaporation slight, then almost every drop of rain will be added to the Ground-water. If the Ground-water lies at a great distance from the surface, and the evaporation is considerable, the soil will necessarily contain much more moisture than if there were little evaporation, and it will therefore not be able to absorb as much of the rain as in the latter case. Further, the condition of the Ground-water will depend on the facility with which the rain can run off the surface: on the direction of the impervious stratum on which the Ground-water rests; on the higher or lower level of the neighbouring district, and the direction in which the neighbouring strata run. These are some of the conditions on which the state of the Ground-water depends, and there are probably others. But it is certain that the rainfall is not so exact a measure of the variation of the humidity of the soil as the changes of the level of the Ground-water; and that it is not, further, so exact a measure, as the latter, of the greater or less mortality from Cholera and Typhoid Fever.

The extremes of drought and wet are alike unfavourable to the development of the Cholera-germ. It will not live in the desert, and it will not live on shipboard. In Calcutta, where Cholera is always present, it diminishes in intensity towards the end of the heavy rains, which last for weeks. Madras has two Cholera-seasons every year, one occurring in February, the other in September. The disease reaches its lowest ebb at the time of the greatest heat and dryness of the year, viz., in June;

and again at the time when the dampness of the ground is greatest, and the temperature is lowest, in December. Why should the disease ebb and flow in this manner? There must be some reason for it, just as for the predilection it shows for certain localities, and the antipathy it has for others. When an epidemic of Cholera breaks out in a town, then all sorts of theories are invented to account for it; it is owing to poverty and dirt, or to the elevation of the place, or the want of ozone or to terrestrial magnetism, or impure water, etc. It has been shown at great pains that the inhabitants of certain parts of London who drank very dirty water supplied by particular water-companies suffered far more than other persons who drank cleaner water. Yet it has never been shown that the water was worse in the year of the Cholera than in any other year; and it is perfectly certain that different localities with the same water-supply suffer most unequally. But when we see Cholera attack some towns very frequently, others only after long intervals, and others not at all, we find it difficult to avoid concluding that there must be some powerful influence resident in the locality, which varies in intensity, at times assisting and at other times being unfavourable to the development of the disease.

The conclusions arrived at by the Cholera-Commission of Bavaria in 1854, *that epidemic Cholera only occurred in places situated on porous ground, permeable to air and water, and in which water could be found at a moderate depth; and that places situated on impermeable soil (rock, etc.) were not visited by Cholera at all, or only in isolated cases*, give birth as it were naturally to some such theory as Prof. von Pettenkofer has elaborated, to account for the facts. He has investigated with extraordinary energy and skill the local conditions of various localities, and has shown that the vast differences of behaviour shown by Cholera in them can be harmoniously explained. For not only does his theory satisfactorily explain the occurrence of epidemic Cholera in some localities at particular times, but it accounts also for the immunity enjoyed by others.

The mode in which the Cholera-germ, when imported into a town from abroad, is developed, and the disease propagated, may be rendered more easily intelligible by the following illustration.

Let us suppose that just before the outbreak of an epidemic

of Cholera in a town some very minute seeds have been imported and dropped into the ground, which had been rendered favourable for their growth by the sinking of the Ground-water, as noticed in the wells. After remaining for some time in the damp soil, the seeds become ripe, and acquire a poisonous character, and rising with the Ground-air float about in the atmosphere. Here they come in contact with the inhabitants, and effect an entry into the bodies of many with the air they breathe, in food or otherwise. A certain number of these take Cholera, and within their bodies the seeds undergo a further development, and their numbers become enormously multiplied. These are expelled with the dejections in an immature state, or at all events not in a state to produce epidemic Cholera until after they have lain in a suitable soil for some time. A sufficient quantity of full-ripe seed might be transported from one town to another with dirty linen, etc., to infect one or two persons directly, but not enough to produce an epidemic. The persons thus infected would be poisoned by the seeds lodged conveyed from the Cholera-district, and to all intents and purposes they might be regarded as having been placed in the same circumstances as those who were living in the infected place, for they would be exposed to the action of the same poison. Now the cases thus occurring through contact with the imported seeds will result in an epidemic if the local and temporal conditions be favourable; otherwise the place will escape in spite of the importation. If now the minute seeds be regarded as analogous to the germs which are the propagators of Cholera, the mode in which the disease is spread, according to Prof. von Pettenkofer's views, will be easily understood. As it is the result of a poison which springs from the soil, it is in this sense a *miasmatic* disease, just as much as marsh-fever.

The germs of the disease can, as stated, be conveyed by dirty linen, and other objects, and also by drinking-water, but this is the only sense in which drinking-water can have any influence on the spread of the disease. Indeed it results inevitably, from Von Pettenkofer's observations, that the Cholera-germ will not come to maturity and assume its characteristic virulence in water, any more than in a perfectly dry soil, such as the burning sand of the desert. The soil which is especially

favourable to its growth is a damp one impregnated with organic matter, a situation in which it is exposed to the action of the air as well as to moisture.

That Cholera is not contagious, in the ordinary acceptation of the term, is established beyond a doubt by authentic circumstances such as the following. A ship puts to sea with a detachment of troops on board, who have come from an infected town. A few days after embarkation Cholera breaks out among the soldiers, but not a single sailor takes it, although they are in constant attendance on them, and live in the closest contact. The disease, in fact, remains confined to those who came from the infected locality; and although their evacuations are exactly similar to those which on shore would produce frightful epidemics, the disease does not spread. Further, Cholera never occurs on shipboard unless introduced by persons coming from an infected locality.

Innumerable cases such as the above are on record, and prove incontestably the necessity for a proper locality. This appears even stronger when we find persons embarking from an infected locality and conveying the disease to a distance without their having shown any symptom of sickness *en route.*

The reason why variations in the Ground-water should assist the development of Cholera and Typhoid Fever is not clear, but a satisfactory solution of the question might be soon looked for if the undeniable fact of the necessary relationship between these phenomena were generally acknowledged. Some light is thrown on the subject by the result of investigations made by Fleck, in Dresden, and Von Pettenkofer, in Munich, into the variations in the composition of the Ground-air. They have found that a few feet under the surface of the ground the amount of carbonic acid in the Ground-air increases greatly, and the quantity becomes greater as we go downwards. It has been further observed that the proportion of carbonic acid becomes much greater in Summer, and especially so in August, which is just what we should expect to be the effect of the increased temperature of the ground on the decomposing organic matter it contains. Now this carbonic acid can be produced neither from the Ground-water itself, nor from the rain; it must be the result of the decomposition of organic matter in the ground.

If this is the case, and it appears undoubtedly to be so, it suggests many points of absorbing interest connecting the greater mortality from Cholera in Summer and Autumn with the greatly increased production of carbonic acid in the ground, a fact which is indicative of greatly increased disintegration of organic matter. The carbonic acid thus produced is of course only a small part of the various substances which this copious decomposition calls into existence; the nature of many of which is quite unknown, though we have strong evidence that it is inimical to man.

I trust that the foregoing brief description may give a clear general outline of the mode of propagation of Cholera as explained by Prof. von Pettenkofer. I have been compelled to do little more than state conclusions, and must refer those who desire more detail to the works, already quoted, of the talented originator of the theory I have endeavoured to explain. There they will find a vast amount of facts bearing on the subject collected and analyzed, and a fund of most valuable information derived from the skilful investigation and comparison of the various questions which have necessarily arisen in the course of an inquiry extending over nearly twenty years.

THOMAS WHITESIDE HIME.

CHOLERA.

Mode of Propagation of Cholera.—Although there are many points relating to the causes of Cholera which are still involved in obscurity, there are others which have been ascertained with a certainty which leaves no doubt. The disease has existed in certain parts of India time out of mind, like Typhoid Fever among ourselves. When the Portuguese first arrived in India, at the commencement of the sixteenth century, after the discovery of the passage round the Cape of Good Hope, they found the disease there, and soon had an unfortunate experience of its epidemic virulence. From certain localities in India, at the present day, it spreads at times over a greater or less extent of the country. Europe was first visited by Cholera during the early part of the present century, a visitation generally and correctly regarded as a result of the increase, and more particularly of the more rapid intercourse between Europe and India.*

Cholera was at first thought to be contagious, because on its first invasion of Europe it advanced, both by land and sea, along the principal lines of traffic. More accurate observation, however, soon showed that in Europe, just as in its native India, Cholera only flourished at particular times and in particular places. It was observed that not only, under exactly similar conditions of traffic, did certain localities suffer most unequally, and some not at all, but also that places susceptible to Cholera are so only at certain times; and, further, that some places are attacked more and others less frequently,

* The first steam-ship appeared in the Indian Ocean in 1826, the first epidemic of Cholera in Europe in 1831.—T. W. H.

although this difference could not be attributed to a difference in the traffic.

Hence it has been concluded that, in addition to the specific Cholera-germ, which originates in India, and is connected in some way or other with human traffic, there must be some other element, not existing within the human body, but connected with the geographical situation, which spreads the poison, and which is not present at all times nor in all places.* This element it is which acts as the local stimulant in the development of the specific Cholera-germ after it has been transported to a locality through the agency of human traffic.

The propagation of Cholera is, therefore, not dependent on traffic alone, but the conditions of traffic, time, and place must all three be simultaneously combined in a favourable manner. To the influence of the two latter factors the terms *local* and *temporal disposition*† have been applied.

Further, it has always been observed that in every district and house subject to attacks of Cholera, the inhabitants suffer most unequally—some seriously, some slightly, and others not at all,—although all were equally exposed to the influence of the specific poison of the disease. The condition of the individual, which determines how far he will resist the disease, is termed the *individual disposition.*

The occurrence of Cholera, and its frequency, depend therefore essentially on the simultaneous co-operation of several, but chiefly of three, causes, viz., the traffic, the local and temporal disposition, and the individual disposition. If one of these factors be wanting, no matter which, there can be no outbreak of Cholera. In order, therefore, to protect ourselves against Cholera, we can work in each of these three directions. The

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* Macnamara, Macpherson, von Pettenkofer, Küchenmeister (Die Lehre von der Verbreitungsart der Cholera), and others, have collected valuable information on the history of the disease. While discussing the antiquity and etymology of dandâliskâ, mordeshin (Fr., mort de chien), vishûjikâ, etc., they have not mentioned the ordinary and generally understood term for Cholera in India—Hija.—T. W. H.

† Disposition is here used in exactly the same sense in which we say in common parlance that a person is *disposed*, or *predisposed*, to take a disease.—T. W. H.

result of our exertions will depend partly on our knowledge, and partly on the influence which we can bring to bear on these three factors. But these three factors must form the centre of every system devised to protect us against the disease.

Let us therefore get a clear idea of what has been established with certainty in each of these three directions, and of what it is in our power to accomplish.

TRAFFIC.—This, the first point for consideration, is the most difficult. Free communication between place and place, and man and man, is such an advantage that we could not deprive ourselves of it even to be protected from Cholera and many other diseases. A restriction of traffic to such an extent that Cholera could not be spread by it, would be a far greater calamity than the disease itself, and the bloodiest wars would be waged to remove the restriction if once imposed. Life is far from being the highest object of man's desires; there are higher ideal blessings for which he must be prepared to sacrifice it. A complete stoppage of traffic has therefore up to the present scarcely ever been attempted, as a general protection against Cholera, but at most only a supervision and regulation of it, by the establishment of military cordons by land, and of quarantine by sea.

However, as so little (not to say nothing)* has always resulted in the way of benefit from both plans, the first especially may be completely disregarded. Quarantine for ships is still often rigorously observed.†

But although the stoppage of traffic is an impossibility, to keep it as pure and free as possible from the contamination of Cholera-poison should be regarded as a practical matter. To

* The difficulty with regard to effective quarantine and cordons may be illustrated by what occurred at Odessa some years ago. A sentinel who was keeping guard over the building in which quarantine was kept took Cholera from the persons inside, and died.—(Zeitschrift für Biologie, Band I., S. 359). How then can the disease be kept confined to the place in which the suspected persons are confined?

"Quis custodiet ipsos custodes?" T. W. H.

† See Appendix, p. 73, for the decision of the International Sanitary Conference, July 1874, on this point.—T. W. H.

accomplish it, however, effectually we should know more certainly and accurately than we now do to what objects the Cholera-germ attaches itself in its passage from one district to another. Hitherto the only conclusion drawn from the fact that Cholera is transportable has been that it is a contagious disease which passes from the sick to the healthy, and while it lasts, produces in the infected persons additional supplies of the poison. But the evident and essential dependence of the propagation of Cholera on local and temporal conditions excites the gravest doubts as to its contagiousness. Experience proves that doctors and attendants in Cholera-hospitals do not on the average suffer more than those who have no intercourse whatever with the sick. It has often been noticed that in large hospitals, which, during the prevalence of epidemics, received large numbers of Cholera-patients, neither the doctors nor the attendants, nor patients who were under treatment for other diseases, became infected. In Calcutta, where the Cholera is constantly present, at times with greater or less severity, somewhat like Typhoid Fever among ourselves, the general hospital has not for thirteen years proved a source of infection to the attendants or to other patients who happened to be under treatment in it, and this although several hundred Cholera-patients have been taken in during that period, and treated frequently in the same wards with other patients. When during an epidemic of Cholera a number of attendants and patients in a hospital take the disease, the fact cannot be regarded as a proof that they sickened owing to contagion emanating from the Cholera-patients, but only as a sign that the hospital has become a centre of *infection*, as any other house may.

The fact that Cholera radiates more from infecting neighbourhoods than from infected individuals, is of the greatest practical importance. It is the most powerful incentive to a fearless attendance on the sick. No one has any grounds for fearing a Cholera-patient who may be under the same roof, and we may unharmed render him any service. If the house has already become a source of infection, the unaffected inmates will not gain the least protection no matter how carefully they may avoid the patient; on the other hand, if the house be not

a centre of infection, and the patient has caught the disease somewhere else, the patient himself cannot be regarded as a source of infection in the house.

In the rare, one might say exceptional, cases in which Cholera seems to arise from contagion—such as when a person passes from a place infected with Cholera to a place free from it, and becomes sick there, and subsequently other persons connected with him take the disease, his attendants, those who have washed for him, etc.,—all the facts can be explained on the assumption that the patient had conveyed with him from the Cholera-district (in some way which still requires investigation) so much of the Cholera-poison that there was enough to infect the other persons who were attacked. Such cases as these, usually regarded as instances of the contagiousness of Cholera, have been most frequently noticed in places which have no susceptibility for Cholera.* Nothing, however, can speak more strongly against the usual assumption of contagiousness than these very cases, because no fresh cases ensue after the first which occurred, and no epidemic has broken out, though the contrary should have been the case had the disease been contagious.

Dirty Linen a Carrier of the Poison.—It may be assumed as a fact that a dangerous quantity of the specific poison of Cholera can be conveyed to a place, previously free from the disease, by means of wearing-apparel, especially if moist and soiled, which has been for some time in a town or house or other place infected with Cholera. The disease thus conveyed may attack those who come into immediate contact with the imported articles,—not, however, because they have belonged to a Cholera-patient, but because they have come from a Cholera-district. If in this invaded locality the necessary conditions

* It is a very remarkable fact, and one which strongly supports the author's views on the propagation of Cholera, that there are certain places in which Cholera has never prevailed as an epidemic. For instance, Lyons, which is situated between Paris and Marseilles, both of which are fatally subject to epidemic Cholera, remains free from the disease, though thousands of fugitives from the latter towns resort to it during seasons of epidemic. Versailles, which is close to Paris, is another town which enjoys immunity. So do Birmingham, Würzburg, and Stutgart.

of local and temporal disposition are coexistent, then the imported poison will not infect merely a small number of those who are brought in contact with it, but will produce a local epidemic. Thus this place will become a Cholera district; whereas if the temporal and local disposition had not coexisted, the cases would have continued isolated or sporadic.

Great care must therefore be taken to avoid sending such articles, while dirty and not disinfected, from houses in which Cholera has been; and those people should also be very careful who have to receive them. Parcels of such things, for instance, should not be opened in the house, but in the open air. The further management of such things will be more particularly treated of under the head of "Disinfection" (pp. 53—58).

Other Carriers of the Poison.—There are many cases on record which point almost decisively to the conclusion that damp, very watery, and slimy articles of food which have been in a Cholera-house, or other centre of infection, are especially likely to take up enough of the poison produced in the infected place to cause the disease in an unaffected place, if they are consumed without being thoroughly purified or re-cooked. Observations to this effect have been made in England and Switzerland with regard to boiled cow's-heel, and in India as to rice cakes.

The steps to be taken in such case will be described in the section on food, when treating of Individual Disposition.

The Excrements as Carriers of the Poison.—In considering the influence of traffic on the spread of the disease, attention has hitherto been generally, if not exclusively, confined to the excretions of the patients, and more especially to the intestinal excretions. When it had been established as a fact that Cholera is spread through the agency of traffic, it became necessary to regard that agency as fixed and localized in something. It was considered the most logical course to assume that the specific poison of the disease is localized in the intestinal excretions, which are so prominent among the phenomena of the disease. Besides, facts gradually induced the belief that the fresh excretions of Cholera-patients are not dangerous, but only such as have become decomposed. The latest investigations, especially in India, the home of Cholera, have not

strengthened the belief in the correctness of localizing the poison in the excretions, but, on the contrary, have considerably diminished that belief. Science is at present investigating with increased attention the modes of propagation of Cholera, and is less concerned to establish the various localizations of the poison on theoretical grounds than on the evidence of facts. This state of our knowledge does not, however, in the least justify us in disregarding the intestinal secretions, as being of no importance with regard to Cholera-epidemics; on the contrary, experience has afforded many reasons for attributing to careless management of the excretions an injurious influence over the local and temporal disposition to Cholera. On this subject more will be said further on (*vide* pp. 48—50).

Henceforth it must not be supposed that anything can be expected from mere Disinfection of the excretions of Cholera-patients; attention must be directed rather to the localities which develop Cholera, and to everything which is connected with and proceeds from them. In other words, we must extend our horizon if we wish to advance. According to the present state of our knowledge, it is not impossible, nor even improbable, that the excretions of Cholera-patients in themselves are quite harmless as to spreading Cholera, and that a house *e.g.* becomes a Cholera-den, not because it has a privy into which the excretions of a Cholera-patient have been conveyed from without, but in a very different and hitherto quite unrecognized manner. This state of affairs and of our knowledge renders it necessary for us in future, if Disinfection is to be at all effective, not to confine our attention to the privies of a Cholera-district, but to look carefully to the various parts of the houses themselves, and to their contents, which hitherto we have entirely disregarded under the influence of a blind belief in the contagiousness of Cholera.

Local and Temporal Disposition.—Since Cholera has been watched in its course over large tracts of country, another influence on its epidemic extension in addition to that of traffic (importation) has become equally noticeable, and often even more so, viz., that of time and place. Hence many have been induced to overlook or even deny the influence, or at least the necessity, of traffic from place to place for the spread of Cholera. Not

long after the first invasion of Europe by Cholera, which lasted from 1831 to 1837, there was a period when the great majority of medical men denied the transportability of Cholera from one locality to another (which then as now was confounded with contagiousness), because it was supposed that if importation were admitted, contagiousness must necessarily be implied. After Cholera had been at first regarded and treated as essentially a contagious disease, owing to the evidence of its importability which was noticed during its advance from Asia through Russia, along the lines of traffic, a great reaction occurred in public opinion in the opposite direction. This reaction occurred of necessity after all the costly regulations founded on the contagionistic theory, such as military cordons and quarantine, had proved useless. It was not until the reappearance of Cholera in Europe in 1848 that people presumed again by degrees to believe in the influence of traffic. But they soon again fell into the former extreme of belief in contagiousness, and again overlooked for a period the essential influence of time and place. Now at length science has opened up a new path, which does not start from *à priori* theories, and pass by all those facts which are irreconcilable with it, but one which proceeds from ascertained facts, assigns to each its due weight and leads step by step to the goal.

That the extension of Cholera does not depend on traffic alone, but also on local causes, is seen in every country subjected to epidemics of the disease. If we inspect a good map on which those places where deaths from Cholera, and especially where epidemics have occurred, are separately and distinctly marked, we shall always and everywhere be struck with the fact that the places attacked by epidemics are *not* grouped around the principal lines of traffic, but according to geographical position; *e.g.*, that the epidemics of Cholera are most unequally distributed along lines of railway. Hence it appears most evidently that traffic alone is insufficient for the propagation of the disease. In every country the localities subject to epidemic Cholera are grouped far more according to river and drainage districts, than according to the chief lines of traffic. The Thuringian districts, Saxony and Bavaria, have been examined with especial care from this point of view; and

in the general report on the epidemic of 1854 in Bavaria, maps are given in which this influence of geographical distribution is shown beyond a doubt.

There are districts and portions of districts which are in a high degree, and repeatedly—often at intervals of but a few years—susceptible to Cholera; and there are also places which have withstood attacks of Cholera, some persistently, while others are only affected after intervals of long duration.

This is not the place to enter upon the subject of the causes of local and temporal disposition, which is still a vexed question among medical men. But according to observations and experiments made in Europe and in India, the home of Cholera, there cannot be the least doubt as to the efficacy, and essential importance, of this factor, the chief causes of which are geographical position, and climatic and atmospheric action on the soil.

So far as the seasons are concerned, Summer and Autumn are the most favourable to Cholera. It happens that the epidemics in individual localities frequently begin earlier or end later than this; but there is hardly another epidemic, importable disease the average course of which exhibits such a regular dependence on the seasons as the Cholera does in our latitude and climate.

This will appear most evidently from a tabulated statement of all the attacks and deaths from Cholera, at fortnightly intervals, which have occurred during all the epidemics in Prussia,* from 1848 to 1860.

* A similar dependence prevails in England, as will be seen from the following table, showing monthly proportion per 100 of all deaths from Cholera in 1832 and 1849:—

	1832, per 100,	1849, per 100,
May	2·41	0·60
June	4·40	3·76
July	13·57	13·91
August	28·69	29·17
September	17·71	37·46
October	13·19	8·58
November	2·59	1·58

Taken from "Manual for Medical Officers of Health," p. 175. By Dr. E. Smith. London: Knight, 1873.

The same is true of the plague in London, during its various attacks from 1640 to 1646.—T. W. H.

From 1848 till 1860 there occurred—	Cases.	Deaths.
between the 1st and 15th April	71 ...	50
,, ,, 16th ,, 30th ,, ...	110 ...	62
,, ,, 1st ,, 15th May	192 ...	112
,, ,, 16th ,, 31st ,, ...	650 ...	334
,, ,, 1st ,, 15th June	3,819 ...	1,961
,, ,, 16th ,, 30th ,, ...	4,894 ...	2,431
,, ,, 1st ,, 15th July	6,106 ...	3,050
,, ,, 16th ,, 31st ,, ...	10,866 ...	5,430
,, ,, 1st ,, 15th August	21,870 ...	11,674
,, ,, 16th ,, 31st ,, ...	41,758 ...	21,966
,, ,, 1st ,, 15th September ...	57,395 ...	31,048
,, ,, 16th ,, 30th ,, ...	45,415 ...	25,513
,, ,, 1st ,, 15th October	35,874 ...	19,462
,, ,, 16th ,, 31st ,, ...	29,903 ...	15,809
,, ,, 1st ,, 15th November ...	21,215 ...	11,363
,, ,, 16th ,, 30th ,, ...	11,621 ...	6,267
,, ,, 1st ,, 15th December ...	8,100 ...	4,246
,, ,, 16th ,, 31st ,, ...	5,665 ...	3,008
,, ,, 1st ,, 15th January	2,857 ...	1,424
,, ,, 16th ,, 31st ,, ...	1,719 ...	893
,, ,, 1st ,, 15th February... ...	909 ...	510
,, ,, 16th ,, 28th ,, ...	687 ...	332
,, ,, 1st ,, 15th March	266 ...	159
,, ,, 16th ,, 31st ,, ...	74 ...	55

In this table we find the influence of the seasons expressed so plainly as to leave no room for doubt, and it is impossible to explain it away on the supposition that it is the traffic which was the active agent. The attacks which occurred before June, and after the first half of January, may be looked on partly as the forerunners of fresh epidemics, and partly as resultants of previous ones.

The temporal influence which betrays itself so distinctly is, in all probability, dependent on climatic influences and the weather, which produce different results in districts which differ geographically, geologically, etc. It would be an error to observe atmospheric influences only during the course of an epidemic; they should be observed uninterruptedly, and especial notice should be taken of what has preceded the outbreak of an epidemic for a considerable time.

Ground-water.—Just as in certain places the existence of typhoid fever exhibits a certain temporal dependence on the variations of the moisture of the soil, of the so-called "Ground-

water," in like manner it is probable that Cholera is similarly dependent, though, owing to the fortunately less frequent prevalence of Cholera, the relationship cannot be so regularly and satisfactorily proved as in the case of Typhoid Fever. Since 1856, observations of the variations of the Ground-water have been regularly made in Munich, and are ready for comparison during the whole of this period of sixteen years.

On the subject of the Ground-water and its influence on diseases, it is not rare to find very erroneous ideas prevalent. Many persons regard the Ground-water as in itself an evil, and think that great results might be obtained if it could be sunk some feet deeper in the ground, and so removed further from them; or if they abstained from drinking it, etc. The variations in the level of the Ground-water in the porous stratum of the ground are important only as showing the variations in the moisture of the superincumbent layers. The importance of these variations in moisture consists in their facilitating or retarding certain organic processes in the soil, while the Ground-water itself may be quite harmless and innocent in the matter. The Ground-water is at present the most accurate measure we have for the variation in the moisture of the soil.

In order to assist the reader in comprehending the importance of the character of the soil of a locality, as affecting the health of the population dwelling on it, it is well to take an individual town and investigate the conditions in its case. For this purpose we will select Munich, which presents especial points of interest because during a period of over sixteen years careful observations have been carried on there as to this point.*

The Soil of Munich.—Munich, with a population of about 170,000, is situated on the Isar. The body of water is not great, and the river has considerable velocity. As a rule, very few families occupy an entire house, it being customary to occupy a flat, as in many other continental cities. Water-closets are a rarity there, and the privies are connected with cesspools of considerable size, to meet the requirements of the number of persons in each house. The surface is level, being part of a large plain extending many miles on both sides of the

* By Prof. von Pettenkofer.—T. W. H.

river. The upper stratum is very permeable to both air and water. The city is built, for a great part, on gravel composed of mountain (Alpine) limestone. This stratum, varying in thickness from twenty to forty feet, rests on a stratum of marl, the depth of which has not yet been ascertained; but it must be at least several hundred feet. Within the city, the marl for the most part does not reach the surface, except on the steep, right bank of the Isar. It is the deposit of an antediluvian inland sea which covered the present elevated plateau of Bavaria during the Tertiary period. It is impermeable to water, and forms the water-tight substratum for the whole district. It constitutes also the floor of the river bed, the Ground-water collecting on it, and gravitating on both sides towards the river. The river bed is the deepest point of the water-tight substratum of marl throughout the district, and therefore the Ground-water drains from both sides towards it.

The intermediate spaces, or pores, existing in the layer of gravel which rests on this impermeable marl, are to a great extent filled with water and air. Such intermediate spaces form more than one-third of the space which even the most compact gravel occupies. It may be said, therefore, that the ground on which the houses of Munich, frequently very lofty and massive, are built, consists of air to the extent of one-third its bulk. This will seem most astounding to those who learn it for the first time; but any one may easily convince himself of its truth by filling a vessel with gravel and shaking it well down until the vessel is filled so compactly that the volume of the gravel cannot be diminished, and then measuring how much water can be poured into the vessel which was apparently full of gravel. More than thirty volumes of water can always be poured in this way on a hundred of dry gravel without overflowing.

This great porosity has advantages and disadvantages, and it is an object of importance, whilst reaping as far as possible the first, to avoid the latter.

Advantages of a Soil like that of Munich.—One of the principal advantages of such a soil is that it confers a great immunity from damp walls. The houses in the immediate neighbourhood of the Isar are not, on the whole, damper than

those at a distance from it. This is a great advantage for the health of the inhabitants. The water which penetrates from the surface into the ground does not stagnate there, because the impermeable stratum of marl on which it collects is not horizontal, but considerably inclined towards the river. This is the reason that the level of some of the wells in the city, even of those most in request, is as much as 20 feet above the level of the river, which is only a short distance away. In fact, the ground-water has a considerable velocity in its fall towards the river, just as the latter has in its fall towards the Ocean. This accounts for the fact that, notwithstanding the carelessness of the people, the spring water is unusually good, compared with that in other cities in which the ground is not so porous, nor the river-drainage so rapid.

Disadvantages of a Soil like that of Munich.—Serious disadvantages also result from the great permeability of such a soil, implying as it does the existence of considerable quantities of air and of large pores in the soil. Within these intermediate spaces there may exist, not only pure water and pure air, but also the most contaminated. It would be incorrect to suppose that the great porosity of the soil allows everything to flow through it, and that it may therefore be regarded practically as an open canal. Unfortunately, though it does allow of a flow of the Ground-water, it also acts like a filter which retains things which it would be a blessing to have removed far away. Recent investigations have shown the active and uninterrupted communication which exists between the air within our houses and that contained in the ground beneath and around them.* When, therefore, organic matter, liable to putrefaction, becomes deposited in the ground, it is just like a dead body which we bury and leave to decompose. This is generally termed 'impregnation of the ground.' The ground round about our houses is far more contaminated by the ashpits, privies, cesspools, etc., attached to them, than a

* No one has done as much in this subject, and the whole department of ventilation, as Prof. v. Pettenkofer himself. See his Article on Ventilation in Wagner's Handwörterbuch der Physiologie; Abhandlungen der naturwissensch-technischen Commission der Königl. baier. Akademie der Wissenschaften, etc.—T. W. H.

churchyard is by the bodies in it, which have six years and even longer for their decomposition, and have a far larger area in which to decompose than the organic offal of the houses in a thickly inhabited town.*

Seeing, therefore, the effects of the porosity of the soil, we must be aware of the necessity of making all receptacles for offal of every kind perfectly water-tight, and doing away entirely with cesspools and all reservoirs in which rubbish of organic matter or impure water is allowed to collect.

Here we find the explanation of the fact, which has been certified beyond a doubt in a large number of towns in England, that with the removal of cesspools, etc., and the introduction of good sewerage and drainage, the mortality of a locality is always diminished, and often to a very considerable degree. Since 1860, when the construction of impervious ash-pits and privies, and the laying down of sewers, has become an established principle, a considerable diminution has taken place in the mortality of Munich. Between 1855 and 1859, on an average, 2½ persons died of Typhoid Fever out of every 1,000 inhabitants; between 1859 and 1869, only 1½ per 1,000.—a reduction of one-third. Although this may be partly due to the improved method of treating the disease, still the diminution of the number of cases is the principal cause. Steady progress in the path of sanitary progress thus opened up will cause a considerable part of the remaining two-thirds to disappear.

It is not true that *every* place where Typhoid Fever occurs is equally susceptible to Cholera; although it is a fact well known that those places which are liable to epidemics of Typhoid Fever are especially liable to outbreaks of Cholera. The more contaminated, the more impregnated the soil of a place is, the more does it favour outbreaks of Typhoid Fever and of Cholera.

Towns built on ground of such a character as that described above have every reason to preserve it as pure as possible, and each house should be subject to inspection with this object in

* Prof. v. Pettenkofer mentions the case of a pump within a churchyard near Munich which actually had much purer water than a well in use in Munich. A well beside one of the churchyards in Munich, a few years ago, supplied better water than any other in the city. T. W. H.

view. Every gutter, shore, and pipe should be tested as to their impermeability, and defective places should be repaired. No cistern or other reservoir for water should be allowed to become leaky, and receptacles for offal (swill-tubs, etc.,) and waste of all kinds should be rendered perfectly water-tight or, better still, done away with entirely. Nothing which can impregnate the ground with decomposing matter should be left lying for any length of time on the surface. The soil has a certain power of rendering decomposing substances harmless, but like everything else this has a limit, and the cases are only too numerous in which far more is left to the ground to disinfect than it possibly can. Every arrangement, every expenditure to secure greater cleanliness in courts, yards, and streets, and to enable the offal to be removed more rapidly, pays for itself * in the improved health of the inhabitants; and this, even though the cleanliness of the surface alone be attended to, as this almost always implies purer air,—of which further on.

The Cholera-Commission (Bavarian) of 1854 ascertained certain facts from their investigation of the circumstances of the epidemic which occurred in that year, and they are well worthy of attention now. Houses and localities situated in hollows, and especially those at the lowest point of hollows, or on terraces, or steppe-like formations close to the foot of declivities, showed in the great majority of cases a far greater disposition for Cholera than houses and localities situated on the summit of a ridge between two hollows, or further from the foot of declivities and sloping ground.

The people who live in such places cannot of course change the situation or leave their houses whenever an epidemic threatens; but since the disadvantages of such positions depends essentially on want of drainage, and the excessive dampness and impurity of the soil which results from it, it is necessary to be much more attentive to the drainage and the cleanliness of houses in such situations than in the case of houses more favourably placed.

Places peculiarly susceptible and unsusceptible to Cholera.—The examination of places which have frequently

* *Vide* "Uber den Werth der Gesundheit," Vortrag gehalten von Prof. von Pettenkofer.—T. W. H.

suffered from epidemics of Cholera offers a ready means of judging of the greater or less susceptibility of different localities which may be of great use. It is well known that certain groups of houses suffer far more when attacked by Cholera than others. The rapid evacuation of such centres of infection has often proved a salutary measure; and in India, at the present time, it is the principal means employed, especially by the military, against Cholera, and with evident good effects.

Before removing from a dangerous locality, it is advisable to know where to go to, as one may change, *De fumo in flammam*, from bad to worse. Places should be chosen which are unsusceptible to Cholera. In seeking for such places, it will be safest to be guided by our knowledge of what has occurred in various localities during the prevalence of epidemics of Cholera, as thus a sure test of susceptibility, immunity, etc., will be afforded.

For example, in Munich different parts of the city and suburbs showed a very different susceptibility to Cholera during the two last epidemics. Munich is so fortunate as to have in its neighbourhood an unsusceptible district, lying along the right bank of the river.* The soil of this district is clay, and supplies the bricks for building purposes in Munich. That a clay soil resting on limestone gravel, through which the ground-water never rises sufficiently high to reach the clay, is unsusceptible to Cholera is a fact which has been often noticed in different places, as well as in Munich during the epidemics of 1836 and 1854. In Munich, Haidhausen, and Berg the epidemic of Cholera confined itself to the houses situated on the gravel, and avoided in a most striking manner those on the more elevated clay. If then it were purposed to remove those who lived in *The Hollow* at Haidhausen, who were more than decimated by the Cholera during the last epidemic, at the right time and to a proper place, it would be necessary to remove them at the first outbreak of the disease to the brick-sheds around Haidhausen, and lodge them in barracks or tents, or some such way, according to the season.

As experience in all epidemics has shown that the disease in

* Extending from Ramersdorf to Ismaning.

individual houses exhausts itself by the end of fourteen days, the evacuated houses might be again occupied after the expiration of that time, when they had been thoroughly cleansed and disinfected from roof to cellar.

Experience as to local and temporal disposition must also be the guide in the selection of sites for Cholera-hospitals, retreats for persons seized with diarrhœa, fugitives from places attacked by Cholera, etc. Families desirous of leaving a town on account of the Cholera will naturally be advised by their medical attendant as to where they ought to remove to.

From what has been here stated as to local and temporal disposition, it will have been seen that every possible precaution must be taken *before* the outbreak of an epidemic. All arrangements, for example, which relate to the protection of the soil from contamination, or its better drainage, will be perfectly useless if they are only commenced at the time of the outbreak of an epidemic; for it requires much time and care before an impure, impregnated soil can be rendered uncontaminated.

Individual Disposition.—Experience has proved that different individuals are affected in very different degrees by the specific Cholera-poison: some it attacks most severely, others slightly, and others, again, not at all. In the epidemic which occurred in the latter part of the Autumn of 1836, in Munich, 2 per 100 of the population were attacked, while in 1854 over 5 per 100 suffered, the mortality on both occasions amounting to about one-half of the cases. In addition, there was a much larger number of cases of diarrhœa and other less serious complaints, which must be regarded as proceeding from the same cause as the more serious Cholera-cases. When in a large house or establishment occupied by a hundred persons, only five are attacked by Cholera, it must be remembered that all the hundred are exposed to the action of the poison. If only five take the disease, there must be some special reason for it, just as there is for the immunity of the ninety-five. It will of course be the desire of every one to be one of the ninety-five rather than of the five. Whatever is required in addition to the specific germ (which is spread by traffic), and the local and temporal disposition (which depend on the locality), in order to produce an outbreak of Cholera in the individual, is termed individual

DISPOSITION. Although the individual disposition cannot be defined and explained with scientific accuracy, still something is known of what tends to produce that condition.

SURVEILLANCE OF THE CASES OF DIARRHŒA.—The transudation of large quantities of water from the various organs of the body, through the lining membrane of the stomach and intestines, is one of the principal symptoms of Cholera. Hence it may be laid down as the first preventative measure to be adopted, to avoid everything which experience has shown to be liable to cause vomiting or diarrhœa. It is a matter of experience that almost every case of Cholera is preceded by a more or less severe attack of what is called choleraic diarrhœa, or cholerine, which lasts a shorter or longer time, and suddenly turns into severe Cholera. At the time of an epidemic, undoubtedly a large number of cases of choleraic diarrhœa occur which never turn into Cholera, and which cease without leaving any bad effects, and this even without medical treatment. But it is equally certain that those cases of diarrhœa which are subjected in time to proper medical attention scarcely ever become Cholera, whereas most cases of Cholera are the result of neglected diarrhœa. This is a fact which is independent of any theory.

Therefore at the outbreak of an epidemic of Cholera the sanitary authorities can hardly undertake any more effective task than to note and make every provision for the careful treatment of cases of diarrhœa. The Bavarian Government deserves great credit for setting an example, which has since often been followed by other countries, in making arrangements for this purpose so long ago as 1836. The capital was divided into ten districts, and in each an establishment with medical attendants was provided. The first duty of these organizations was "*the early discovery of the premonitory signs of the disease, by daily visits of the medical officers to the houses of the healthy in their respective districts; and the rendering of immediate assistance where required.*" Of course the people must aid these establishments in effecting their object, by reposing confidence in them, and giving information, and if necessary availing themselves of their assistance.

In several places which have lately been attacked by Cholera

special establishments have been provided to meet these premonitory outbreaks, which give warning of the approach ot Cholera,—so-called Diarrhœa Stations. These have proved to be of great service, but always *provided they are erected in a suitable site.**

Since diarrhœa plays so important a part in epidemics of Cholera, it is well to consider often the question as to what it is most commonly caused by. Among the most frequent and general causes of diarrhœa are chills and errors of diet. In the case of the former, it is essentially a disturbance of the natural thermal arrangements of the body, more particularly of the radiation of heat from the body, which is chiefly regulated by the skin; in the case of errors of diet, it is a question of a disturbance of the digestion and absorption of food by the lining membrane of the stomach and intestines. In both instances precautions can be taken in the selection of clothing and food.

Clothing, and Attention to the Skin.—The clothing, which most persons consider chiefly in regard to beauty of appearance and as an adornment, performs such important physiological and hygienic functions, that it should be reckoned among the greatest of human discoveries, and one which could least be dispensed with. Our clothing provides us with an atmosphere of great mildness and equality of temperature (about 30° C., = 86° F.,) over the whole covered surface of our bodies. The constancy of the temperature of the blood and internal organs of our body (37½° C., = 99½° F.,) is a law which cannot be violated without producing a bad effect on the health whether the variation be an increase or a diminution.

Seeing the great changes in the temperature of the surrounding air, and of neighbouring objects, it would be impossible for man to satisfy the above law, even when well clothed, were he not provided by nature with a very delicate and sensitive regulating apparatus. This apparatus consists of the nerves which

* The most important point with regard to the situation is the selection of a site which will not develop the Cholera germ if introduced; the question of its being central, etc., is only of secondary importance in comparison. It is far better to have no stations or hospitals at all than only to have such as are centres of infection, *i.e.*, which are built on a soil favourable to the development of the germ.—T. W. H.

regulate the size of the blood-vessels,* and it is constantly in a state of activity, without our being at all aware of it. Should the temperature of surrounding objects fall, or a frost set in, it straightway closes more and more the paths by which heat escapes from the body; should the temperature around rise, it opens them up. It is literally true that the cooling of the skin protects the interior of the body for a time from too great loss of heat, and the converse is equally so, viz., that warming of the skin, and perspiration, cool the interior of the body. This regulating apparatus must, however, be kept in order, and be ready for work, and it must not be called on to do more work than it is intended for.

Practice is required for every kind of work. If a person, therefore, were always to live under exactly the same conditions of production and loss of heat from his body, the heat-regulating apparatus in his skin would become weak. A certain amount of daily change of conditions is therefore necessary for health, but the change must not be too great nor too rapid for the power of the regulating-apparatus, nor such as to prevent the corresponding equilibrium being re-established. The exercise of this apparatus we call 'hardening,' the want of it effeminacy or delicacy; and mistakes may be made in either direction. The person who has to spend the day within doors at quiet work derives great benefit from exercise in the free air, if only for a short time; while taking it he feels a healthful glow permeate his whole frame. The person whose work within doors requires more exertion, produces in consequence more heat, and wears correspondingly lighter clothes; he too requires to breathe the fresh air better clothed, and it refreshes and cools him. The person who must spend the day and work in the cool open air, takes pleasure in sitting for a time in a warm room by the fire. The body seems to require this change, so that it may not always have to work in one direction only, and that it may be able to take rest from time to time in different ways—one set of organs, etc., resting while another is in a state of activity. But, as before mentioned, the change must never exceed the capabilities of the regulating apparatus of our bodies; it must never be too great nor too sudden.

* So-called Vaso-motor nerves.—T. W. H.

This power which resides in the skin of regulating the amount of heat given off from the body is also called into action in the performance of the various operations which we practise to maintain its cleanliness and activity. The most important of these is of course washing partially, and bathing the whole body. It is not only the person who is in a faint who is refreshed and benefited by having water thrown on him; the person in good health is also benefited by the same operation.

Washing not only removes the dirt, but it invigorates the skin and nerves. Bodily cleanliness is therefore one of the most important means of promoting good health.

We effect this cleanliness not only by washing our bodies with soap and water, but also by the aid of our inside clothing. Frequent change of linen may be compared to a dry bath. Instead of plunging our own body in the water, we put the linen in and purify it from the dirt which it has collected off our bodies. As at the time of the splendour of the ancient Greeks and Romans, the State constructed gigantic supplies of water, so that each person, even the poorest, should be able to bathe at least once a day, so it should be one of the objects of the public health authorities of our day that each should have linen to change at least once a week.

The general introduction of linen and cotton for clothing, and the use of soap* for washing, is undoubtedly a great advance in hygiene in our day as compared with antiquity. But just as baths alone cannot accomplish every object, so neither can our linen alone. Our age may fairly be reproached with neglecting the bath too much. The skin is such an important organ, working incessantly in different ways for us even when we least suspect it, that we have every reason to devote the greatest attention to it. It is not too much to expect that every one should at least once a week thoroughly wash himself in a tepid bath for a quarter of an hour. The skin well deserves this care in return for the work which it performs, the bath only freshening it up for renewed exertions.

* Pliny says soap was a Gallic invention, and was originally composed of fat mixed with ashes. (Nat. Hist., Lib. xxviii., cap. 51.) He adds: "Optimus fagino et caprino: duobus modis, spissus ac liquidus: uterque apud Germanos magore in usu viris quam feminis."—T. W. H.

What has been said about our clothing is equally true of our bed, which is not only an apparatus for taking rest in, but also exercises a great influence over the thermal arrangements of our bodies; and it may prove a source either of great benefit or harm, just as our clothes can. The bed is a sleeping garment, and whoever has no bed, or does not sleep in it, not only does not rest well, but endures considerable alteration and derangement in the heating economy of his body. Nothing promotes the circulation in the skin and over the whole surface of the body like the warmth of the bed. By this means the internal organs are partially relieved from the force of the circulation, and obtain repose. Rest in bed for a portion of every twenty-four hours is, therefore, quite as beneficial, only in a different manner, as exercise in the open air.

From what has been said above, the following rule may be derived: Our clothes are intended essentially to protect us from cold, but without interfering with transpiration. Chills drive the blood from the surface of the body, and very frequently cause over-filling of internal organs, and especially catarrh of the mucous membranes, diarrhœa being one form of such catarrh.

During epidemics of Cholera it is especially advisable to keep the abdomen and feet warm, and for this purpose flannel swathes or binders, and woollen stockings, are very useful.

Good beds, clean linen, and good clothes are the most effective means against derangements of the natural transpiration from the body. The question of assisting the activity of the skin by means of internal agents (such as peppermint or camomile tea, negus, etc.,) should be left to the medical attendant to decide, as well as the question of taking occasionally vapour or Roman-Irish baths.* The repeated use of baths, especially

* This is what is commonly known in this country as the Turkish bath. It is not a little strange that even in Ireland this kind of bath should be called 'Turkish.' The Turks certainly did not invent this bath; they wisely adopted it when brought to their notice. The 'Sweating-house,' or Tig Allui, is undoubtedly of great antiquity in Ireland, and autocthonous, and was a popular institution long before the arrival of the Romans in England.—T. W. H.

by those unaccustomed to them, calls for only one consideration, viz., the ready tendency to catch cold before or after them.

The production, radiation, and distribution of heat in our bodies are not promoted by the influence of our clothing alone, assisted by the healthy action of the skin; the houses we live in also exercise an important influence over them, especially as regards the manner and degree of the ventilation and warmth maintained. The essential functions performed by our houses are to be estimated from the same point of view as our clothes.

Secret Remedies; Patent Medicines.—This is a suitable place to give a most earnest warning against the use of so-called secret remedies and patent medicines. There is no secret antidote to Cholera. If any one knew of such, it would not be necessary for him to keep it secret; its publication would secure him the largest reward from whole nations, even if only one-half of what he professed were true. If the educated and experienced physician is the best adviser of the family in ordinary times, he will be so in a still higher degree during an epidemic.

Diet.—People must eat even when Cholera is raging. It is a matter of general experience that ill-nourished people are far more susceptible to Cholera than those who are well-nourished. What is known so far, with some certainty, as to disposition for Cholera, may be briefly summed up as follows: since the essential phenomenon of Cholera is the transudation of water from the organs of the body into the intestinal canal, everything must be of importance which favours or gives rise to such transudation. Its occurrence is favoured by everything which unduly irritates or relaxes the bowels, or drives the blood from the surface of the body towards the internal organs; further, by everything which either increases the amount of water in the organs of the body, or interferes with its escape from them.

In order to establish and maintain such a state of bodily health as will, according to experience, best resist the influence of Cholera, the food should be moderate in amount, but sufficient, nutritious, and easily digestible. No exhaustive and universal rules can be laid down on this point, as the dif-

ferences between individuals are often very great. It is well, therefore, for sanitary authorities to abstain from attempting to recommend any particular dietary during times of Cholera, although hitherto official programmes giving advice as to how to act during Cholera-epidemics have generally not been deficient on this point. Each individual must provide for himself in accordance with what his judgment and experience have taught him on this subject. Most persons follow such official dietaries only to a limited extent, making numerous variations as they think best; and the few anxious individuals who endeavour to eat according to rule, do themselves far more harm, by their anxiety, than good. The sanitary authority, therefore, will do best to confine its advice on this point to recommending people to eat and drink during Cholera-times whatever has tasted good and agreed well with them at other times, and only to avoid every excess. Whatever has proved injurious at other times should be avoided with still greater care during an epidemic of Cholera. Those who habitually pay attention to their health know far better than any one can tell them what has at ordinary times usually caused heaviness in the stomach, cholic, and diarrhœa; what has diminished the appetite, lain long in the stomach, disturbed the sleep, or caused an aching head in the morning.

If it is a matter of importance at ordinary times to avoid all articles of food which are not fresh or sound, it is doubly so at a time of such danger as during an epidemic. The authorities should therefore redouble their care in the inspection of markets and provision stores of all kinds, and each private individual should do his best to assist them in this work.

No sudden and permanent benefit to the health can be secured by a temporary improvement in our diet, as it takes weeks before our bodies become habituated to a change of food. The people should be especially well fed at the time of an epidemic which is either approaching or has already broken out. Soup-kitchens, and establishments where a good meal of nourishing food can be got at the lowest possible price, are therefore of the greatest benefit.*

* It must not be supposed, however, that cheapness and bulk are the

If it is at all times most desirable that the greatest cleanliness should be maintained in the kitchen and in cooking, it is doubly so during an epidemic. As already mentioned, there is a certain danger in eating things which have come from districts where Cholera prevails, as some of the poison may be attached to them. Our present knowledge justifies us in assuming that the Cholera-germ is destroyed, or at least essentially changed in its nature, by being exposed to a *boiling temperature*. It may therefore be regarded as a rational precaution to consume no meat, vegetables, milk, etc., during Cholera times, which have been obtained out of the house without having thoroughly cleaned or boiled everything beforehand.

Drink.—The general rules laid down with regard to food apply also to drink. We should not let ourselves suffer from thirst during an epidemic of Cholera, but we should avoid taking excess of fluids, and drink no more water, beer, or wine than is necessary to allay our thirst. Persons accustomed to great quantities of spirituous liquors, especially brandy, always die of Cholera in a large proportion.

Drinking-water.—If pure drinking-water is necessary for health at ordinary times, it is still more so during all epidemics. Many persons ground the necessity for pure drinking-water chiefly on the widespread assumption that the inhabitants of many places have suffered from epidemics of Typhoid Fever and Cholera which were generated in their wells. This assumption

only items to be considered. The constituents of a good, nourishing meal must be properly proportioned according to the amounts of Albumen, Fat, and Hydrocarbons they contain ; and further, the digestibility of the food is a very important matter, being, in fact, a measure of the quantity of it which becomes absorbed, and thus helps to nourish the body and repair its waste. Prof. Voit has shown that ¼ of the albuminoid substances consumed with a diet consisting of bread alone is often excreted quite undigested. This large proportion of the food is, therefore, in such cases perfectly useless as nourishment, and the money spent on it is quite wasted. The daily food of an adult, in order to maintain his body in vigour, should contain, in the most digestible form, at least 470 grammes (500 grammes = 16 ozs.) of dried Hydrocarbons (starchy food , Albuminoid Substances, and Fat, in addition to water, various salts, etc. The food supplied at public soup-kitchens, etc., is often far behind the figures here stated, and consequently insufficient in quality, though not perhaps in quantity. Finally, food must be agreeable in flavour, or it will prove unsatisfactory.—T. W. H.

is as old as the hills, and during the prevalence of epidemics, both long before and during the Christian era, has often led to violent measures being taken against those suspected of having poisoned the wells.

It is not necessary to adopt this assumption in order to appreciate correctly the value of pure drinking-water; and, indeed, serious objections may be raised to it, especially in the case of Cholera and Typhoid Fever. It is quite superfluous to regard pure water as a panacea or specific remedy for Cholera and Typhoid Fever, and then to get perplexed whenever a town well provided with this requisite is nevertheless attacked by an epidemic. Impure water in the body is like other impurities in a house; both are injurious, even when there is no Cholera or Typhoid Fever present. If people who have dirty water and dirty houses suffer more during epidemics than others, the explanation may possibly be that they suffer *also* in health when there is no epidemic more than persons who drink pure water and keep their houses clean. There are places where the people are very uncleanly and drink very bad water, and yet never have Cholera or Typhoid Fever. However, notwithstanding the absence of epidemics, they have a higher rate of mortality, and enjoy a less average length of life than persons who attend better to sanitary matters.

Importance of Purity of Water, Air, and Soil.—Under all circumstances, it is a matter of importance for the public health to have the drinking-water as pure as possible, not merely during temporary epidemics, but at all times. It should be a matter beyond the bounds of credibility that in the nineteenth century men must still be driven to be clean by terror of a specific disease; just as people often try to induce children to act rightly by terrifying them with fictitious alarms. The advantages of pure water, of pure air, and of a pure soil would be much underrated if it were assumed that they are of importance and value only during the prevalence of particular temporary diseases; they are always so, since they spare our bodies much useless wear and waste, and therefore loss of power; thus they render us healthier and stronger and better able to resist all diseases, and consequently Cholera and Typhoid Fever.

Our bodies are fortunately not so weakly and delicately organized that we are unable to resist and overcome dangers and injuries; but our power of resistance to injurious influences has its limit, and cannot hold out beyond a certain degree: it is a self-evident proposition that the more one has to overcome, the sooner will exhaustion set in. A particle of dust cannot, it is true, instantly stop a clock, but the clock will go much longer if it be protected from dust.

Every one knows the value of avoiding or diminishing all unnecessary sources of friction and heating in a machine; cleanliness, convenience, and propriety are of equal importance in the general economy of human life. What is called domestic comfort, in the widest sense, embraces no specific against any particular disease, and yet is of the greatest importance for our health. During the last two centuries specific diseases have not diminished in England—rather the contrary, and Cholera has been added to them. Investigations founded on the Registry of Births and Deaths in London show that the mortality has kept continually decreasing along with the increase of the city and the population, or perhaps more correctly in spite of them.

From 1681 to 1690 the population of London was about 530,000.
„ „ the mortality was yearly 42 per 1,000.
From 1746 to 1755 the population was 653,000.
„ „ the mortality was yearly 35 per 1,000.
From 1846 to 1855 the population was 2,362,236.
„ „ the mortality was yearly 25 per 1,000.
At present the population is about 3,000,000.
„ the mortality is about 22 per 1,000.

Pure Air in the House.—This is one of the most important points to attend to in the domestic economy. We should not only have pure and wholesome food and drink, but also pure and wholesome air. The latter is but too often neglected. We live in the air, like fish in water. The fish-keepers in cities, who have to preserve their fish alive in reservoirs, pretty much like men in their houses, know well how much depends on the water, and how injurious every impurity is. Man should be quite as particular about his dwelling-place and the air in it. He must renew the latter continually with fresh, wholesome

air, and must take care that it is not contaminated by the house itself before ever he can breathe it. The air does not merely surround us continually, but we must constantly take it into the interior of our bodies, as we inhale and drive it out again. The quantity of air which a grown-up person, breathing on an average sixteen times each minute of the twenty-four hours, consumes in his lungs, just as we consume food in our stomachs, is far greater than most persons imagine. It amounts to about 2,000 gallons in the twenty-four hours. This is more than 2,000 times the bulk of the food and drink we consume in the same time.

It might be supposed that, as the air is so light, the above quantity if weighed would not be greater than the weight of our food and drink. But this, too, would be a mistake, as the whole of the solid and liquid food we take in twenty-four hours is not one-third the weight of the air we respire during the same period. The weight of the air we consume every twenty-four hours actually amounts to twenty-five pounds avoirdupois.

The consumption of air is, therefore, in every aspect, one of the most important elements of our daily life; and hence the greatest possible purity of the air is one of the most important necessities for health.

The air in unconfined places has a very uniform chemical constitution, and may usually be regarded as pure. That within our houses is constantly varying to a certain degree, even against our wishes, and without our interference. A house has no special air of its own; it contains only a part of the air of the place where it is situated. While we live in the air which flows from the open through our houses, and necessarily remains a longer or shorter time within them, it becomes contaminated in various ways,—partly unavoidable, and partly avoidable. Amongst the unavoidable sources of contamination is the action of the skin and lungs: as we only cease to defile the air in this way with life itself. Amongst the avoidable sources of contamination, we must reckon everything which, owing to want of cleanliness or to carelessness in the disposal of offal, etc., passes as dust or gas into the air. The air should be used for counteracting the effects of respiration and evaporation from the skin. It is possible by

increasing the rapidity of the change of the air in our houses to prevent it becoming too much contaminated. However, it is an improper use of ventilation to employ it as a means of getting rid of avoidable impurities; and, indeed, it is generally not of much use for this purpose. It would be far better to remove bad-smelling substances, dust, or dirt entirely out of a room than to increase the ventilation with the intention of getting the draught to do what we could do ourselves more advantageously. Prevention is always better than cure; and it is much more rational to prevent all avoidable pollution of the air, than to try to remove the bad effects of it afterwards by more frequent and stronger ventilation. Without rigorous cleanliness in a house, arrangements for ventilation are of little or no avail. Ventilation comes properly into play when cleanliness, by rapid removal or careful shutting off of whatever could pollute the air, has done all that is possible for it. This is the case with impurities introduced into the air by the action of the lungs and skin, against which ventilation alone can be of service.

Whoever desires to protect himself against a future epidemic, be it of Cholera or Typhoid Fever, should commence at once to secure the greatest possible cleanliness in his house, not only in the show apartments, but in every corner of it, and to ventilate every part of it regularly with the greatest care. The smaller or more crowded a house or room is, the more necessary it is to keep it perfectly clean and well-ventilated. If the air in a house is to continue wholesome, it must be frequently changed. In a covered-in space inhabited by several persons there should be an average allowance of 1,320 gallons of air per hour for each person, an amount which must seem astounding to those who hear of it for the first time.

In order to avoid the dangers which are often erroneously supposed to arise from excessive change of the air, or, as it is usually termed, from draughts caused by windows opened entirely or partly,* we can either aerate the rooms one after

* All draught can be effectually avoided, and perfect aeration of the room secured, by opening more or less of the window and nailing a piece of linen, or similar material, across the open part. The window in a sick room may be kept open night and day, if thus protected, even during the

another, and thus avoid being in the one which is being attended to, or else open the upper part of the windows, where this is possible.

It is not sufficient to ventilate once every day, or for any particular length of time: it must be done according to the necessity of the case, according to the degree of the impurity of the air, and to the greater or less rapidity with which it is renewed. When there is a brisk wind blowing, and the difference of the temperature inside and outside is considerable, the interchange between the air within and without a house takes place much more rapidly that when the air is still, and there is no considerable difference between the temperature inside and that outside the house. Far less air will pass through one and the same window in the latter case than in the former.

Even when the windows and doors are quite closed, there is a constant interchange between the air in the interior of our houses and that outside, proportional to the rapidity of the wind, and the difference between the internal and external temperatures. This interchange takes place partly through unavoidable chinks, partly (and principally) through the pores of the materials of which the walls are built. For a wall of dry brick we may calculate for each square metre (= 1·196 yard) of outside wall, and for each 1° C. of difference of temperature between the interior and exterior of the house that from fifty-five to fifty-six gallons of air will pass through the wall of every house.* If this source of ventilation is to be

coldest weather, provided of course the temperature be kept up by means of a fire or stove. Far more people are injured by deficiency of good air than by an excess.—T. W. H.

* At first sight it will appear almost incredible that such an amount of air can flow through the apparently solid walls of our houses. But our inability to recognize the fact is entirely due to the slowness with which the air moves. As a fact we do not perceive any movement in the air around us unless it have a rapidity of about three feet per second, such is the bluntness of our organs of sense. The permeability of ordinary bricks, mortar, sandstone, and other building materials, to air, may readily be proved by experiment. If, however, they be damp, it becomes impossible to force one particle of air through. Hence one great disadvantage of damp walls. They are further, as stated in the text, disposed to chill that side of our body which is next them, because they themselves are kept cool by the evaporation from their surface, and also by their beco

utilized, one condition is essential, viz., that the wall be dry, because damp walls are quite air-tight, and further act injuriously by chilling our bodies on the side which is next to them, and thus giving rise to colds and other more serious complaints.

No instrument has been yet devised which can, in the hands of ordinary people, tell the purity of the air, with the same ease and correctness as the thermometer tells the temperature. But bad air makes so decided an impression on our organ of smell, that we may allow ourselves to be guided by the smell of the air in our rooms in estimating its purity, and the necessity for a change: always being guided by the impression made on us immediately after breathing fresh air out of doors.

To improve unwholesome, bad-smelling air by admixture of nice-smelling substances (so-called fumigation) is an impossibility, because the injurious substances present in bad air are not changed or destroyed by such means: our organ of smell is only pleasantly deceived. It is not from this to be supposed that every smell which is agreeable is injurious, but only that the artificial production of an agreeable smell must not be regarded as a means of disinfection, nor must it replace ventilation in our houses. A real improvement of the air can only be effected by thoroughly changing it, and introducing fresh air.

If it be desired, during Cholera-time, in addition to efficient ventilation and aeration in our ordinary and sick rooms, to produce an agreeable smell, it will be best to employ a harmless volatile acid along with some ethereal oil. Sprinkling with vinegar, acetic acid, or so-called aromatic acetic acid, or simply letting some evaporate in the room, is never injurious, and indeed disinfectant and antiseptic properties may be attributed to acetic acid.

For a very long time it has been usual to place chloride of lime in places with bad air, although hitherto without any particular effect from it having been demonstrated. The hypochlorous acid which is set free from the chloride of lime,

good conductors of heat—much better than dry walls. The radiation from our bodies is thus increased—chiefly, however, on the side nearest the wall.—T. W. H.

by the action of the carbonic acid of the air on it, has the property of altering and destroying most organic substances. But for the complete destruction of all the organic matter in the air, far more Chlorine is required than what is produced by exposing chloride of lime to the air. An atmosphere which contained so much chlorine that no organic or organized matter could exist in it, would be irrespirable for men. It must not be forgotten that our own bodies are composed of organic matter, which is attacked by chlorine just as much as the injurious organisms which we desire to destroy. To inhale active disinfectants with the air is as impracticable as to take them combined with our food or drink.

A place which is to be disinfected by gaseous disinfectants cannot be occupied by human beings during the operation. Particulars on this point, will be given when treating of Disinfection (pp. 61—66).

There are certain parts of our houses from which especially impurities emanate and pollute the air, and to these, therefore, we must give more particular attention. These are the water-closets and privies, the outlets for slops, the receptacles for the offal of the kitchen, and the places where soiled clothes are kept.

Water-closets and Privies.—The ideal water-closet, or privy, is one which would prevent even the slightest pollution of the air or soil by any substance originating in the excretions. The water-closet is the best arrangement for preventing the escape of gas or air from the pipes into the house. It of course requires a supply of water which must be raised at least to the level of the closet, and it also necessitates an arrangement of pipes or drains for permitting the immediate carrying away of the contents of the soil-pan. It is not applicable where the pipes discharge into a cesspool, as the quantity of water used would necessitate emptying them too often. An adequate ventilation of these pipes and sewers is of vast importance, but it must be arranged so that the air and gases from them cannot get into the house, but may be able to escape directly into the open air. It might be supposed that this is, after all, but a bad arrangement, because, instead of entering the house directly, the gases, etc., escape

into the air by which the house is surrounded, and thus must get into the house. There is no ground for this fear. The average speed of the air in the open is 10 feet per second, which is so great that such emanations are immediately so much diluted that they are rendered imperceptible and harmless. It is just the same as with the smoke which is conducted from our fireplaces into the open air, and our houses are thus rendered free from smoke without the air being spoiled.

It has become a question of great and pressing importance how to dispose of the offal of our bodies and households so as not to pollute the air, the soil, or the water-supply, and to do this cheaply and effectually. Without, however, entering upon this problem, which involves engineering as well as chemical and physiological questions, often of great difficulty, and could not, therefore, be satisfactorily discussed within the limits of this little work, it will be advantageous to consider what can be done at the time of an epidemic to diminish existing difficulties. Besides maintaining the greatest possible cleanliness in closets, etc.,* by flushing them often and thoroughly with water, and if necessary scraping out old pipes, etc., there are two principal means by which we can considerably diminish the danger of polluting the air; these are,

(1) Thorough ventilation of the closets, privies, sewers, etc.

(2) Disinfection of the excretions.

Every one knows that a closet, privy, etc., smells less unpleasantly as soon as its window has been opened. Most persons explain this on the supposition that the smell goes out of the window instead of remaining inside. The real explanation is that when the window is opened, the draught upwards towards

* Prof. von Pettenkofer in his direction as to privies had in view those which are common in Munich, but fortunately are unknown in England or Ireland, and, it is to be hoped, soon will be unknown in Scotland. In Munich, the people, as a rule, live on flats, only a few of the very wealthiest families having an entire house to themselves. One cesspool, into which pipes open from the various flats, receives the excretions of all the residents in the house, who may number thirty, forty, fifty, or even more persons. The arrangements are often the most rude and unhealthy. I have endeavoured to utilize such of the author's remarks as are applicable to the arrangements usually found in English houses, omitting what was inapplicable.—T. W. H.

he house from the pipes and drains is lessened. So long as the house, or any part of it, is warmer than the external air, there will be a draught of the heavier and cooler air from without towards the warmer place within. Now the difference in the pressure is equalized by the passage of air through the shortest and easiest way; and when the closet window is closed, this is from without through the drains and pipes into the house; but when the window is opened, the readiest way is through it, and hence the draught from below ceases, and with it the smell. Therefore the smell does not escape out through the window, but fresh air comes in through it, and consequently the strength of the draught up the pipe is lessened.

Conversely, it is for the same reason necessary that the cesspools, sewers, etc., and the pipes communicating with them, be as air-tight as possible, so that draught may exist from them towards the interior of the house. One of the chief causes of the bad smell in water-closets is a deficiency in this point. For the same reason it is advantageous to let the pipe or shaft from the cesspool or sewer be carried up undiminished in size over the roof, and open into the air. By this means, if the draught from below into the house be prevented, or even rendered difficult, the draught up the shaft, and through it into the open air above the house, will be facilitated, and the easier its escape the less danger is there of a draught into the house from below. But so long as the draught from the receptacle below is not prevented, air will be able to get from the receptacle into the closet, and from thence into the house.

The management of portable closets, so-called night-chairs, etc., will be described in the section which treats of Disinfection (*vide* pp. 61—66).

As the decomposition which commences in the excrements soon after their discharge is one of the most fruitful sources of pollution of the air, everything which tends to prevent this decomposition must be regarded as a means of diminishing the evil. The name of 'Disinfectants' is given to the substances employed for this purpose. Those which are best adapted for the disinfection of water-closets, privies, sewers, etc., will be treated of in the section on Disinfection (*vide* pp. 61—66).

Sinks.—The so-called sinks for carrying off the waste-water

of the kitchen, etc., are frequently regular poisoners of the air in the houses they belong to. They are usually placed in the kitchen, and generally open into gutters or pipes which are either quite open or badly protected, and in which the discharged matters rot. So long as there is a fire in the kitchen, indeed so long as the kitchen is warmer than the outside air, which is the case almost the whole year round, so long, in accordance with unchangeable physical laws, must air flow from without through these pipes into the kitchen, carrying with it whatever it can take up, such as gas, or particles of decomposing matter, etc., in its passage through this very dirty channel. This serious evil can only be prevented by the use of what are technically called syphons or traps, which are a very simple arrangement for making the pipe or sink open into a receptacle containing water, and thus protecting the end of the pipe from the air, and preventing its entrance.

Swill and Manure.—No less care must be devoted to securing the earliest possible removal of all other kinds of offal, such as are often collected in the so-called swill-tubs, etc. In the country such things are usually thrown on the dunghoap, which involves no such disadvantages as the plan of putting them into deep ashpits, which is common in towns. In the case of the dunghill in the country, there is not only the free access of air to the surface, which acts beneficially, but also the layer of ground under it is placed so much higher than the bottom of an ashpit usually is. It has already been mentioned that every porous soil has a certain power of destroying substances injurious to health. It is self-evident that this power must be greater in proportion to the extent of the soil which has this effect. The peasant throws his manure on the heap lying on the surface of the ground in his yard, leaving the ground under it undisturbed. In the towns we have the very same dunghills, but instead of being on the surface of the ground, they are in sunken, covered-in pits, over which we move about without sinking, just as if the peasant were to put boards over his dunghill to stand on. But in order to be able to roof our pit well, and to be able to get the appearance of the greatest superficial cleanliness, it is necessary to dig out and remove, to a considerable depth, a large part of

the layer of earth, which would be of service as a disinfectant. If these pits, therefore, are not water-tight, they contribute far more to the impregnation of the soil than the countryman's dunghill; and if by any means the air of the house communicate with the air in such a pit, it is evident that far more polluted air will get into the house than if air merely passed into the house over a manure-heap lying in the open air.

Soiled Clothes.—It is self-evident that the rooms, boxes or other receptacles in which soiled clothes are kept until they are washed, contain not only the clothes, but also the dirt attached to them. These receptacles are therefore receptacles for dirt, like water-closets or privies, and pollute the air like them, and possibly give rise to various highly injurious processes just like an impregnated soil. It is a striking fact, and one long since deserving of closer investigation, that linen and cotton clothes which have been worn smell much stronger than woollen clothes. A woollen shirt which has been worn for a month does not smell nearly so badly as a linen one which has been worn only a week. If it is advisable, under ordinary circumstances, not to allow collections of soiled clothes to be kept for a length of time, it is much more so during an epidemic. Anyhow it will be best to keep the soiled things hung on lines not in the house, unless they can be washed at once, but in an airy loft or outhouse.

During an epidemic it is very advisable to steep all soiled clothes, immediately after they have been taken off, in a strong solution of quicklime or caustic soda for some hours, then to rinse them out well in fresh water, and if the washing cannot be finished at the time, to dry them and lay them by.

Importance of the Housewife's Position.—For securing scrupulous personal cleanliness in each member of the family and in every part of the house, as well as conscientiously providing and preparing wholesome food for the family, no one can do so much as the well-informed and ever-watchful housewife. The office of the housewife is equally important and honourable both during the time of epidemic disease, and when there is no such danger; for nothing fortifies the health and increases the power of resisting disease in each member of the family so much as when in the particulars mentioned

everything is regulated in the best manner in a household. Housewives can benefit the public health by activity in these departments far more than even if a large number of them were to study and enter on the practice of medicine.

Work and Rest.—For the enjoyment of health we require not only good air, good water, and good food, as well as suitable clothing and lodging, but we must also have occupation, both bodily and mental. This, however, must not be excessive, and should be interrupted by periods of rest. Excesses in this direction are quite as predisposing to Cholera as excess of any other kind,—as, for example, of eating or drinking. Persons whose occupation is chiefly indoors should take exercise every day for a time in the open air. When the weather prevents outdoor exercise, we can make up for it fairly by exercising in a room with open windows.

Persons occupied with the care of Cholera-patients should take especial care to maintain their bodies in such a state of vigour as to offer the greatest resistance to the disease. Scrupulous cleanliness, good, comfortable beds and clothing, a sufficiency of nourishing food, plenty of sleep and fresh air, are most strongly to be recommended.

Disinfection.—Disinfection means the destruction of the poisons which cause disease, or rendering them inert. To infect or poison means just the opposite to disinfect, which means to deprive of the power of poisoning. Two conditions are necessary if disinfection is to be really efficacious: 1st, the object to be disinfected must be the one which chiefly, if not exclusively, contains the poison; 2ndly, the disinfectant employed must really destroy the poison, or be able to render it inactive.

At the time when the Cholera-poison was assumed to exist exclusively in the excrements, disinfectants were applied to them only, and to vessels and other objects likely to be tainted by them. The history of disinfection is intimately connected with the development of our knowledge and opinions as to the nature and mode of propagation of Cholera, just indeed as all sanitary regulations are determined by the state of knowledge at the time. For practical reasons, therefore, it is necessary to develop and perfect the theory as far as possible, because on it

will depend the regulations which we shall adopt in practice. At the very first appearance of Cholera in Europe, attempts at disinfection by fumigation were made, but during the epidemic from 1833 to 1837, as a rule, disinfection was not practised at all. Things remained pretty much in this way during the epidemics of 1848 to 1854, and it was not until 1854 to 1859, shortly before the Cholera left Europe, that experiments with disinfectants were renewed. Since its return, from 1865 to 1867, disinfection of the excretions has been more systematically employed and tested.

If it be demanded of experience what has hitherto been the advantage of disinfection,—whether the course of Cholera in places where there were epidemics when disinfectants were employed and when they were not, has been different, and such as to prove that an undoubted benefit arises from their employment,—unfortunately the answer must be that the question is still undecided. In 1836, when in Munich the disease was not regarded as at all contagious, or as transportable by traffic, 1 per 100 of the population died of Cholera; while in 1854, when the transportability of Cholera was generally acknowledged, and its contagiousness (by means of the excretions) was generally assumed, and from this point of view combated in various ways, 2½ per 100 of the population died. The epidemics of 1866 in many of the cities of northern Germany, *e.g.*, Erfurt, Leipzig, Stettin, etc., were among the most severe which ever visited those cities, and yet never before was disinfection so generally and so diligently practised as in that year.

Ought we then to abandon disinfection? Decidedly not; for it may have hitherto proved unavailing because the Cholera-poison does not exist exclusively, or even at all, in the excrements, or because we have not employed the proper disinfectants, nor employed them in proper quantity nor in the proper manner. It is an important duty of the public health authorities to determine this question with greater certainty, when another opportunity arises. A rational plan of experimentation is the first thing to be devised, and this is all the more necessary because without it we can never escape from our present uncertainty, and arrive at either a positive or negative conclusion.

Whatever opinion may be held as to the specific result of the disinfection of excrements, its value as an essential means of maintaining cleanliness cannot be denied, any more than the fact that there are many places and occasions where it is very desirable. Let any one think for a moment of many of our railway stations, hotels, and other places of common resort, in parts of which it must be really painful for any one to remain for even a few minutes who is accustomed to good air. If the Government, therefore, through its health officers, should not only recommend, but in certain cases enforce, disinfection, it will be acting wisely.

Disinfection of Privies and Cesspools with Sulphate of Iron and Carbolic Acid.—The disinfection of excrements, privies, cesspools, and other receptacles for offal, has advantages, as already observed, quite independent of the question whether they contain any specific poison or not. As the excrements are usually managed, they generally poison, more or less, the air of our houses, and it is a matter of experience that the purer the air we live in, the healthier we shall be. Every impurity is an obstacle which our organism must get the better of if it is to continue healthy. If, therefore, under ordinary circumstances the purity of the air is conducive to the health of our bodies, and to our power of resisting noxious influences, this will be far more the case during the prevalence of an epidemic, and pure air will be much more necessary then.

The excrements vitiate the air most when they are allowed to become decomposed, and to undergo alkaline or ammoniacal fermentation before they are got rid of. When in this condition they give off more in the shape of gases, etc., to the air than when they are fresh and acid. In proof of this, one need only think how little smell there is from fresh urine, and what a stink is developed from the same urine when it has commenced to decompose. It is, further, a matter of experience, that a mixture of urine and solid excrement which is acid when fresh,* does not, even if kept a long time, give off any-

* This can be readily tested by touching it with a piece of blue litmus-paper (which can be got at any chemist's), when it will be found that the blue colour will instantly be turned to a reddish one by the action of the acid.

thing like its ordinary bad smell, when substances have been added to it which maintain its original acidity, and prevent the formation of ammonia; or which, if this has commenced, restore its original acid condition. It may therefore be regarded as a certainty that whenever arrangements exist in a house which admit of the excrements being kept for some time, and do not prevent the escape of the products of their decomposition into the open air, the air in the house will be improved in quality when the excrements are treated in the manner alluded to, i.e., when they are kept in their original acid condition, which is what is usually termed 'Disinfection of the excrements.'

We can accomplish this end, the prevention of the decomposition of the excrements, or at least the prevention of the escape of the products of decomposition into the air, by different means,—not only by means of acid substances, such as sulphate of iron, but also by means of substances of quite an opposite character, viz., which give an alkaline reaction, such as freshly slacked lime. The alkaline disinfectants have however various disadvantages, especially when employed on the contents of old cesspools and ash-pits. Free mineral acids have other disadvantages which render them undesirable for general use. For disinfection on a large scale, such materials only are applicable as do not when employed develop any considerable quantity of gases from the decomposing and fermenting excrements, and which, further, are sufficiently cheap and easy to obtain everywhere.

Considered from these various points of view, no disinfectant has been so much approved of as a mixture of sulphate of iron and carbolic acid. But it is not sufficient merely to use *some* sulphate of iron, and *some* carbolic acid; they must be used in sufficient quantity.

Amount of Disinfectant to be used.—The quantity of disinfectant to be employed will, in a general way, be that which renders the excrements, and whatever is mixed with them, acid, and keeps them so until they have been removed from the neighbourhood of the house.

The excrements of one person will require daily about six drachms (8 drachms = 1 ounce) of sulphate of iron dissolved in one quart of water. This calculation, however, assumes that the excrements to be disinfected are fresh, and are not mixed

with old matter which has already become alkaline; and that the latter has either been removed before the disinfection, or else has been treated with sulphate of iron until it has lost its alkaline reaction, and again become acid.

The excrements can be kept acid (*i.e.*, disinfected) by the use of sulphate of iron alone, or, as is very advisable, by a mixture of the sulphate and some carbolic acid. The latter should not be used alone. If about 31 grains of crude carbolic acid (dissolved by shaking in a couple of ounces of water) be added to the quantity of sulphate of iron daily required for each person, viz., 6 drachms, it will suffice to use about one-third of the quantity of iron, *i.e.*, 2 drachms per head for disinfecting. The employment of carbolic acid, therefore, effects a saving of the sulphate of iron.

Control of the Disinfection.—The quantities of sulphate of iron and carbolic acid which have been named must be regarded only as averages. The objects to be attained being to render and keep the excrements acid, the determination of their being so or not can alone decide whether the disinfection has been efficient or not. This can be determined by taking up on a clean rod a drop of the fluid which contains excrement, and putting it on a piece of blue litmus-paper, and observing whether the paper is turned red by it, which will be the case if it is acid.

In order to ascertain whether, on the other hand, the excrement is alkaline, a drop of the liquid is placed, in the same manner as before, on a piece of yellow turmeric-paper, which will be turned a reddish-brown if it is alkaline.

The smell will show whether a sufficient quantity of carbolic acid has been used or not.

To test the air in privies, water-closets, etc., for the presence of decomposing and not disinfected excrementitious matter, let a piece of moistened turmeric-paper be laid with one end between two little bits of glass, and the other end hanging free, and let the free end be exposed for a few minutes to the air which is to be examined. Ammonia is given off from all decomposing excrements, and if even the smallest quantity of it exist in the air under examination, a marked change in colour will be noticed between the part of the moistened

turmeric-paper which is between the pieces of glass and the exposed part, the latter turning reddish-brown, while the former retains its yellow colour. All night-stools and other receptacles can be examined in the same way.

Various other Disinfectants.—It is often difficult, or quite impossible, to render large soil pipes, sewers which are difficult of access, etc., quite free from smell and ammonia, if a liquid disinfectant be employed, because the liquid cannot be applied to every part. In such cases it will be best to employ fumigation, by burning a sufficient quantity of sulphur in the place to be disinfected. The sulphurous acid developed by this process is a gas, and will make its way into every crevice. It is one of the very best disinfectants.

Chloride of manganese and the soluble salts of zinc (the sulphate and chloride) may also be used instead of the sulphate of iron. The salts of zinc are dearer than the iron, but have the advantage of not causing ironmould stains, as it is liable to do.

Disinfecters.—As in the event of an epidemic the disinfection of privies, etc., will, it is earnestly to be hoped, be generally enforced, it is desirable that some persons should be instructed in the methods to be employed, under the supervision of the public health authorities. If it is desired to disinfect a house so as to purify the air, it should be done as completely as possible, because it costs but little more than an imperfect disinfection, and unless thoroughly done it is perfectly useless.

Sojourn in Cholera-Districts.—Everything which comes from a Cholera-house or neighbourhood to which the poison of the disease can adhere, requires peculiar attention with regard to cleanliness and disinfection. That a brief sojourn in a place where Cholera is present is not sufficient to cause infection is quite evident from the case of medical men who attend Cholera-patients. No one comes so much in communication with persons and places affected with Cholera as doctors, and yet they are not attacked in greater numbers than persons who have nothing whatever to do with the disease.

The case of the doctors affords the strongest evidence also for the fact that a mere passing visit to a person or place

affected with Cholera, if the visitor takes nothing away with him except what may be suspended in the air, does not tend at all to spread the disease, because there is no case on record of a doctor having caused an epidemic of Cholera through his visits. Even if Cholera were a contagious disease, which it is not, it is impossible to apply to it the ordinary views which are in vogue about contagion and the mode of its propagation.

We ought not to visit Cholera-patients (the majority of whom are to be found in localities which are productive of the poison) except when unavoidably compelled. But if from any cause it be necessary to do so, we need have no great anxiety if we only use the same caution as the doctors, who never consume anything in houses where the disease exists, except the air which they inhale, and take nothing out of the house with them. The air which unavoidably adheres to us and penetrates our clothes in a place where Cholera exists, as well as elsewhere, is straightway got rid of when we go into the open air, and is, so to say, washed away.

Experience as to the importation of Cholera-poison from an infected to a healthy neighbourhood in sufficient quantity to produce an epidemic, points very clearly to the conclusion that such importations occur proportionately only very seldom, and that therefore some peculiar conditions must be required for their occurrence. Up to the present the only known instances, which are free from all doubt, have been in the case of dirty clothes, especially the linen of Cholera-patients, and watery, slimy food. Such objects seem to be capable of attaching to themselves in a Cholera-district, and maintaining in an active condition, sufficient poison not only to serve as the seed for the development of an epidemic, but even to cause several cases of the disease, without being increased in quantity at all.

Especial attention must be devoted to such objects coming from infected neighbourhoods. If possible, they should not be brought at all; but if they must be, it should only occur under special precautions. These precautions are perfect cleanliness and drying or disinfection.

Disinfection of Goods from Cholera-Districts.—The first precaution requires no further notice; the second, disinfection, may be carried out as follows:—

Articles made of linen and cotton may be most simply disinfected by being steeped in hot lye made with freshly-slaked lime,—so-called caustic lye. Woollen articles, cloth, horsehair, and feathers, may be boiled in water or fumigated with sulphur. Things of no value, such as straw, should be burned.

Meat, sausages, milk, and other, especially slimy, articles of food, and also fruit and vegetables, which by any possibility may have come from a Cholera-neighbourhood, should (in addition to careful washing, as already mentioned) be thoroughly boiled before being eaten, during the prevalence of an epidemic.

Disinfection and Cleansing of Places affected with Cholera.—The wider the conviction spreads that Cholera *proceeds more from infected places than from persons who have been infected by them,* the more will efforts at disinfection be directed to the places in which the disease is rather than to the patients and their excrements.

An infected place cannot be efficiently disinfected while there are people in it; because if we wish to establish conditions which will destroy an organic poison present in a place, we must render it for the time unfit for man to live in. Places which are to be properly disinfected must be unoccupied. It is a fact independent of all theory, which has been observed in every epidemic of Cholera, in every place, and on every occasion, that the attacks in each individual house terminate on the average within twelve or fourteen days; there are exceptions, but they are extraordinarily few. This rule can serve as a guide when it is desired to leave any place and occupy it again after a time. While it is unoccupied there is plenty of time to have it thoroughly disinfected and purified. The best plan of disinfecting closed places is by means of fumigation with burning sulphur. A person may fumigate the unoccupied rooms of his house in this way, just as the cooper does an empty wine-cask, in order that the wine may keep better. During the disinfection with sulphur (fumigation) the windows and doors must be kept fastened as closely as possible. Afterwards the place must be thoroughly ventilated and cleansed, and along with the remains of the sulphur every particle of dust and dirt must be removed.

The disinfection and cleaning of unoccupied houses will also

with greatest advantage be entrusted to specially instructed persons, under the supervision of the public health authorities.

Concluding Remarks.—The foregoing pages are not intended as an exhaustive treatise on the precautions and rules to be followed as a protection against Cholera, which will enable each individual independently to contend against an impending epidemic: they are only intended to direct attention to certain essential points towards which the individual and the public alike should strive. It is hoped that, founded as they are on observation and experience of the past, they may initiate an understanding and a reconciliation of different views which are essential to an advantageous co-operation between the general public and the authorities. This little work is therefore not to be regarded in the light of a director, but rather as an instructor to render those rules and directions intelligible, some of which are in existence, and others probably would be put in operation on the outbreak of an epidemic.

APPENDIX.

Conclusions arrived at relative to Cholera, by the International Sanitary Conference held in Vienna, in July 1874.

The International Sanitary Conference was held at the suggestion of the Austro-Hungarian Government, and consisted of thirty-nine deputies, representing twenty-one governments of the Old and the New World. The conclusions were adopted by vote, each member having the liberty to vote for or against any resolution, or to remain neutral. The discussions as to Cholera occupied so much time that it was found impracticable to entertain questions relating to other epidemic diseases. The unanimous conclusion of the delegates that a permanent International Conference should be appointed to consider and advise on epidemic diseases, is one which will be hailed with satisfaction by all interested in the great question of public health.

The business of the Conference was divided into four parts, as follows :—Firstly, Scientific questions ; Secondly, Questions relating to Quarantine ; Thirdly, As to the formation of a permanent International Commission for the Investigation of Epidemic Diseases ; Fourthly, Questions relating to Yellow Fever.

The following are the conclusions arrived at* :—

FIRST PART.

SCIENTIFIC QUESTIONS.

I.

ORIGIN AND GENESIS OF CHOLERA.

Asiatic Cholera, susceptible of spreading (epidemically), is spon-

* The conclusions arrived at on the scientific questions are given here at length; those on the questions in the second, third, and fourth parts, have been briefly summarized.

taneously developed in India, and when it breaks out in other countries, it has always been introduced from abroad. It is not endemic in any other country but India. (Unanimously adopted.)

II.

QUESTIONS OF TRANSMISSIBILITY.

1. Transmissibility by Man.—Cholera is transmissible by man coming from an infected locality; but man is not considered as the specific cause, apart from the influence of locality; he is regarded as the propagator of Cholera when he comes from a place where the germ of the disease already exists. (Unanimously adopted).

2. Transmissibility by Personal Effects.—Cholera can be transmitted by personal effects coming from an infected place, especially such as have been used by Cholera patients; and certain facts show that the disease can be carried to a distance by these effects if shut up so as to prevent free contact with the air. (Unanimously adopted).

3. Transmissibility by Foods and Drinks.—(a) *Foods.*—The Conference not having conclusive proofs of the transmission of Cholera by foods, decided by eleven States against seven that it was not justified in coming to a decision on this question. (Eleven Ayes, seven Noes.)

(b) *Drinks.*—Cholera can be propagated by drinks, particularly by water. (Unanimously adopted.)

4. Transmissibility by Animals.—No proof exists of the transmissibility of Cholera by animals, but it is reasonable to admit the possibility of such transmission. (Ten Ayes, two Noes, six Neutrals.)

5. Transmissibility by Merchandize.—Although it is unanimously admitted that proof is wanting of the transmission of Cholera by merchandize, still the Conference admits the possibility of such transmission under certain conditions. (Thirteen Ayes, five Neutrals.)

6. Transmissibility by Cholera Corpses.—Although it is not proved that Cholera corpses can transmit Cholera, it is prudent to consider them dangerous. (Unanimously adopted.)

7. Transmissibility by the Atmosphere alone.—No fact is yet known which proves that Cholera can be propagated to a distance by the atmosphere alone, whatever its condition. Moreover, it is a law, without exception, that an epidemic of Cholera is not propagated from one place to another in a shorter space of time than it would take a man to travel the intervening distance.

The surrounding air is the principal vehicle of the generative agent of Cholera; but the transmission of the malady by the atmosphere, in the immense majority of cases, is restricted to the close

vicinity of the focus of emission. As to facts asserted of transportation to a distance of one or many miles, they are not conclusive. (Unanimously adopted.)

8. Action of the Air upon the Transmissibility.—It results from a study of the facts that in free air the generative principle of Cholera rapidly loses its morbific activity; but that in certain conditions of confinement this activity may be preserved during an undetermined time. Great deserts form a very efficacious barrier against the propagation of Cholera. There is no instance of this disease having been imported into Egypt or Syria, across the desert, by caravans from Mecca. (Unanimously adopted.)

III.

DURATION OF INCUBATION.

In almost every case the period of incubation—that is to say, the time which elapses from the moment when an individual has contracted the choleraic intoxication to the commencement of the premonitory diarrhœa or of confirmed Cholera—does not exceed a few days. All the facts cited of a more prolonged period of incubation refer to cases which are not conclusive, either because the premonitory diarrhœa has been included in the period of incubation, or because the contamination may have occurred after departure from the infected place.

Observation shows that the duration of the choleraic diarrhœa called premonitory—which must not be confounded with other kinds of diarrhœa that may exist where Cholera prevails—does not exceed a few days.

The facts instanced as exceptional do not prove that cases of diarrhœa of lengthened duration belong to Cholera, and are susceptible of transmitting the malady, when the person affected is removed from all source of contamination. (Fifteen Ayes, one No. four Neutrals.)

IV.

QUESTIONS AS TO DISINFECTION.

1. Are any means or processes of disinfection known by which the generative or contagious principle of Cholera can be *certainly* destroyed or deprived of its intensity? (Twelve Noes, seven Neutrals.)

2. Are any means or processes of disinfection known, by the application of which there is *some chance of succeeding* in destroying the generative or contagious principle of Cholera, or of depriving it of its intensity? (Thirteen Ayes, five Noes.)

3. Science does not yet know any certain and specific measures of disinfection; but the Conference recognizes the great value of hygienic measures, such as ventilation, thorough cleansing, etc., combined with the use of the substances regarded as disinfectants. (Unanimously adopted.)

SECOND PART.

QUESTIONS OF QUARANTINE.

I.

QUARANTINE BY LAND.

Seeing that quarantine by land is impracticable and useless, on account of the numerous and daily increasing means of communication, and seeing that commercial interests would necessarily be seriously affected by it, the Conference expresses its disapproval of quarantine by land. (Thirteen Ayes, four Noes, two Neutrals.)

II.

QUARANTINE BY SEA.

1. Measures to be adopted out of Europe.—With the view of preventing fresh invasions of Europe by Cholera, the Conference expresses its approval of the measures recommended by the Conference of Constantinople, more especially the quarantine in the Red and the Caspian Seas.

The quarantine in these places should be carried out in a complete and satisfactory manner, and according to the most rigorous maxims of hygiene.

2. Measures to be adopted in European Ports.—When Europe has been invaded by Cholera, the Conference recommends a system of medical inspection to be adopted; but lays down the basis of a system of quarantine for such states as prefer to maintain that precautionary measure.

A. SYSTEM OF MEDICAL INSPECTION.

The medical inspection to be carried out in each port open to commerce, should be performed by a sanitary authority composed of medical and lay officials.

Ships coming from healthy ports to be left free: ships coming from suspected or infected ports to be rigorously inspected.

If no death from Cholera or suspicious case have occurred on board, the ship is to be left free. But if any case of Cholera, or of a suspicious character, have occurred, the ship, the passengers, and all personal effects to be rigorously disinfected; all patients on board to be removed immediately to an isolated hospital.

B. SYSTEM OF QUARANTINE.

ARRIVALS FROM INFECTED PORTS.

Such arrivals to be kept in quarantine for periods of one to seven, or even, in exceptional cases, of ten days, during which thorough disinfection is to be carried out.

ARRIVALS FROM SUSPECTED PORTS.

Ships coming from suspected ports (*i.e.*, near to and having free intercourse with infected ports) may be kept under observation for not longer than five days.

Special precautions may be adopted in the case of emigrant ships, and in other cases of peculiar gravity.

III.

QUARANTINE ON RIVERS.

The arguments against quarantine by land are equally available against quarantine on rivers. The system of medical inspection recommended by the Conference is applicable in such cases.

THIRD PART.

PROJECT FOR THE CREATION OF A PERMANENT INTERNATIONAL COMMISSION OF EPIDEMICS.

The Commission, which is to be purely scientific, is to be located at Vienna; its expenses to be provided for by the governments which take part, by their delegates, in it. The etiology and prevention of Cholera to be the chief subject of investigation; and observations are to be carried on in various countries to this end. Among other subjects of inquiry the following are specified:—

1. The regular and continuous study of the amounts of rainfall and evaporation at certain cities.

2. The scientific investigation of the telluric conditions of these same cities.

3. The thorough investigation of the question of the propagation of Cholera on shipboard; attention being, for the time, especially directed to certain specified lines of traffic between the East and Europe, Europe and North America, etc.

4. The determination of the first case of Cholera in each epidemic, and the collection of complete statistics as to the march of the disease in Europe.

5. The determination of the precise period of incubation of Cholera.

FOURTH PART.

It was determined to refer the questions on the subject of Yellow Fever to the Permanent International Commission.

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